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OF THE

Sanitary Commission

OF THE

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Compliments of Dr. W. T. Goldsmith.

MEMBERS OF THE COMMISSION.

J. P. LOGAN, M.D., PRESIDENT,
V. H. TALIAFERRO, M.D., SECRETARY,
W. T. GOLDSMITH, M.D.,
CH. RAUSCHENBERG, M.D.,
HON. L. DEGIVE,
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SANITARY COMMISSION

OF THE

CITY OF ATLANTA, GEORGIA.

1876.

The Sanitary Commission for the city of Atlanta was created by the City Council, as follows:

"By Councilman Richardson—

"*Resolved*, That a Sanitary Commission be appointed for advisory purposes, to take under consideration the question of drainage and the disposal of the refuse (especially the excreta) of the city, consisting of Drs. J. P. Logan, W. T. Goldsmith, V. H. Taliaferro, Hon. John Collier, Hon. N. J. Hammond, L. DeGive, W. J. Garrett and John Stephens; that said commission shall make the most thorough investigation practicable, as to the different systems of drainage and disposal of refuse, and report to the General Council, at their earliest convenience, the result of their investigations. The commission shall perform their duties without compensation, and shall have the authority to invite any person or persons before them for a free and full discussion of this subject. Adopted."

Under the above authority, the Commission met January 8, 1876, at the room of the Police Commissioners, and organized by the election of Dr. J. P. Logan as President, and Dr. V. H. Taliaferro as Secretary.

On motion of Dr. V. H. Taliaferro, the following resolutions were adopted:

"*Resolved*, 1. That a committee be appointed by the Chairman, to obtain all the information accessible upon the subject of the disposal of refuse, and the plan best adapted to the city of Atlanta.

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"*Resolved*, 2. That a committee be appointed to take under consideration the matters of drainage and sewerage, the different systems, relative cost, etc.; obtaining all the information to be had upon these subjects."

At the next subsequent meeting the President appointed as these committees the following:

On the disposal of excreta, etc., Dr. W. T. Goldsmith, Hon. L. DeGive and Capt. W. J. Garrett.

On drainage and sewerage, Hon. John Collier, Hon. N. J. Hammond and Col. John Stephens.

On Motion of Dr. W. T. Goldsmith:

"*Resolved*, That all persons having plans for drainage and the disposal of the excreta of the city, are cordially invited to submit such plans at the meetings of the Commission, verbally, or by written communication."

Adopted.

At a meeting of the Commission, held February 15, 1876, the Secretary read the resignation of Hon. John Collier, which, on motion, was accepted. His Honor the Mayor, and City Council, being notified of the vacancy, elected Dr. Ch. Rauschenburg to fill the place.

At a subsequent meeting, the President appointed Dr. Rauschenburg as chairman of Committee on Drainage and Sewerage, vice Hon. John Collier, resigned.

Meeting of the Commission held March 13, 1876, the following communication was received:

"*By the City Engineer to the Mayor and General Council:*

"Let the present system, carrying both flood water and sewage, remain common, as far as the south side of Fair street, at its junction with Loyd street, then continue from that point with a pipe sewer, to the corporate limits, carrying all the branch water, (except floods) which will aid the water-works very materially in flushing a pipe sewer. Where the large sewer connects (at Fair street) with the pipe, the flood water, after the pipe becomes full, will escape into the old channel. The large sewer then becomes only a matter of importance to the owners of the land, who may, as property enhances, be induced to sewer it for the value of the land reclaimed over it.

"Referred to the Sanitary Commission, by the City Council."

At a meeting of the Commission held May 3, 1876, the following communication was received and read:

OFFICE OF THE CITY ENGINEER,

ATLANTA, GA., May 1, 1876.

To the Sanitary Commission:

GENTLEMEN:—By building the following lines of main sewers there will be no necessity of more mains for several years to come, and these will suffice for the lateral or sub-sewers of the whole present area of water pipe house connections.

By continuing the present sewer recently started at the junction of Loyd and Fair streets, along the natural drain parallel to a point a little beyond McDonough street, at a cost of $8,000, a distance of one mile of elliptic 22x28 pipe, all the filth and excrement from the corner of Forsyth and Marietta, in the Fifth Ward, the Passenger Depot, in the Fourth Ward, Forsyth street, from Alabama street in the First Ward, to Peter's street, and Peter's street to Castleberry's Hill, also, in the First Ward, and the area bounded by McDonough street, in the Second Ward; on the East, comprising fully one-fourth of the population of the city would have an outlet to which lateral pipe sewers and house connections can be speedily connected at an average cost of $8,000 per mile for 15 inch pipe. Then by commencing near junction of Peter's alley and Line street, in the Fourth Ward, and running down Line street to Ivy, thence down the natural drain which runs under Longley & Robinson's shop on Butler street, and extending it to intersection of Ellis street, for $8,000, one mile of 22x28 elliptic pipe, we could cut off all the filth that accumulates from the corner of Forsyth and Grubb streets, in the Fifth Ward, and now runs down the drain North of Gilmer and South of Wheat streets, by tapping as suggested at Peter's alley, near Line street, and much improve the sanitary condition of that portion. The total length of the water pipe line from Hon. C. C. Hammock's house, laid at present, is four miles throughout the city; and if we had to lay a corresponding amount of sewer pipe it would only make $12,000 for an average of 15 inch pipe, which would connect the fronts of houses with the two mains above mentioned, making a total of $28,000, but there can be much pipe sewer already laid utilized by simply changing the location of it and making it deeper, and arrang-

ing proper ventilation as proposed and heretofore explained In fact, as the city increases the natural drains will define the routes for future mains in the distant future. In fact the minute details will be subject to careful surveys hereafter to be made. I have sufficient information as to minimum grades and areas to be drained to give the foregoing as an estimate approximately correct and not too small.

Respectfully submitted,

H. T. McDANIEL, City Engineer.

At the same meeting (May 3d,) Dr. Rauschenberg, chairman of committee on drainage and sewerage, read the following report, which, on motion was received:

ATLANTA, GA., May 3, 1876.

To the President and Members of the Sanitary Commission of the City of Atlanta:

GENTLEMEN—As chairman of your Committee on Sewers and Drains, I respectfully submit to you the following report:

GENERAL CONSIDERATIONS.

If your action in appointing a Committee on the Removal of Refuse and Excreta, besides that which I represent this evening, and the general tenor of the discussions had at our previous meetings, enable me to arrive at conclusions, the most material points of difference of opinion amongst ourselves, as well as the main object of deliberation for our body, will be best met by a careful consideration of the following questions:

(1.) Is the removal of all decomposable fluid, and solid offal, by water carriage, in properly constructed drains and sewers, preferable to its removal by carts or any other means?

(2.) Is the water supply of Atlanta, the topographical condition of its surface and the geological condition of its soil, such as to offer any serious obstacles to drainage and sewerage, or such that it becomes unavoidably necessary as the most effective and most economical mode of removal?

(3.) Does a system of sewerage and drainage permit of the final disposition of the refuse and excreta in such a manner that they become innoxious to the surrounding country and useful for agricultural purposes?

Before entering into the consideration of these questions

I beg leave to remind you of the fact, that the final and sole object of our investigation consists in the selection of what, in our judgment, constitutes the most complete, efficient, and economical method for Atlanta to prevent excrementitious, and other decomposable and deleterious substances, to enter and pollute the soil, water and atmosphere, and thereby diminish the occurrence of disease and death with their ill effects upon the prosperity of the individual and the community at large.

If we should be able to recommend to our City Council a method which will, at a reasonable, and, in course of time decreasing cost, secure a permanent and increasing protection against disease, without becoming a molestation and injury to the surrounding country, we will solve the problem and accomplish the object for which this Commission has been called into existence.

In the selection of this method, we should, therefore, give preference to that one, which accomplishes this removal:

(1.) In the most complete and perfect manner, so that the smallest possible amount of any of the solid or fluid decomposable substances shall be left within the borders of the city.

(2.) In the shortest possible time, so that all the deposits of a certain period of time are carried beyond the limits of the city within one, or, at the utmost, two hours afterwards; hence, long before the process of decomposition commences.

(3.) In the most inoffensive manner to private and public comfort and decency.

(4.) In such a manner that the products of this removal do not only not injure the health, and interfere with the comfort and rights of the surrounding country, by pollution of the running water, but can be converted into fertilizers or otherwise utilized for the cultivation of crops, or improvement and restoration of poor lands.

I trust, gentlemen, you will pardon me for making these general remarks. They were unavoidable, because I had to define my position in relation to the demands, which should be made, at the present day, on a perfect system of sanitary works, before I could expect to convince you that the system I advocate—that of ample water supply, by water-works, with proper sewerage and drainage, after the latest principles of sanitary engineering—complies with all of them, and is, there-

fore, the best, and the only one which, in cities of any size, fulfills the demands of public hygiene.

I. Is the removal of all decomposable fluid and solid offal, by water-carriage, in properly constructed drains and sewers, preferable to its removal by carts, or any other means?

Direct removal and its modifications.—The only method which has been used in cities for the removal of refuse and excreta, on a large scale, outside of depositing them in either good or, still oftener, bad sewers, has been that of direct, systematic, removal of fecal matter and refuse, by manual and horse labor, for the purpose of manufacturing fertilizers, with the expectation of realizing a profit.

Theoretical calculations based upon estimates of the quantity and value of the fæces and urine of the inhabitants of a city, showing a large value, and a considerable chance for profit, have given rise to these efforts. A communication from Rev. Rob. Logan, on the same subject, and directed to this body, a short time since, tells us, in the same manner, exactly how many pounds of fæces and how many gallons of urine are deposited in Atlanta every day, and that these substances, according to the market value of the fertilizers they contain, are worth $128,000 per year; that it will only take 14 carts, at a cost of $28 per day; or $10,220 per year, to gather and remove them, and that a profit of $117,880 will remain to the city, which, if it even should be consumed in the manufacture and sale of fertilizers from this refuse, would still leave the city financially intact, and improve its sanitary condition.

These theoretical calculations and conclusions of Rev. Robert Logan sound very plausible, but are nevertheless, like many others made before, utterly erroneous and futile in practice. It is a great pity that there is such a great difference between the amount of fæces and urine produced by the inhabitants of a city and the amount which—no matter how favorable the arrangements to serve that purpose may be—can be made accessible, collected, and really taken off on carts. Wherever this method has been used, a system of accessible privies, with easily moveable sheet-iron tubs or buckets, subject to hermetical closure, has been established; and still the result of years of trial has shown that a large portion of the fæces, and over half of the urine—a four times more valuable fertilizer than

the former—are lost in this method. Many houses are so located that it becomes very difficult to arrange accessible privies, the contents of which can be removed in a reasonable time. Then much of the urine is not deposited in the privies, and as the vessels frequently overflow before removal, by the careless addition of waste kitchen and house water, the manurial value of their contents is thereby diminished, and the cost of transportation, by the presence of useless material, increased. The unreliability of laborers and the carelessness of the inmates of houses, make a systematic execution and control of this mode of removal exceedingly difficult. Then it is hardly possible, without the employment of a very large force, to remove more than once a week, and therefore decomposition—particularly in the summer months—sets in, causes more or less unpleasant and unhealthy effluvia, containing ammonia and sulphuretted hydrogen, at a not inconsiderable loss to the manurial value of the substances to be removed; and thus the quantity and quality of the fertilizing material is considerably diminished, the expense of removal increased, and the sanitary and financial merits of the method considerably lessened.

The expense of this mode of removal, in comparison to its sanitary value and the value of the fertilizers manufactured, is by no means small. The interest on the first outlay for carts, mules, harness, and tools; the permanent monthly expense for repairs, overseers, laborers, food and care of animals, would of course differ in different places, according to the price of labor. In Germany, where labor is much lower than here, the average cost of the removal of these substances per annum amounts to at least one florin to each inhabitant, and everywhere the contractors, who remove and manufacture the refuse, receive a bonus of about that much from the city, per head, outside of the offal itself, to enable them to keep up their establishments. The cash loss of the city of Paris on its cartage system, to the Depotoir de la Vilette, is yearly about $75,000, and none of the many stock companies and enterprises for the removal of excreta and manufacture of fertilizers have ever been able to hold out any length of time, or realize a profit. These are facts known to every one familiar with the leading European works on this subject. Rev. Robert Logan estimates the value of the contents of the excrements of one hu-

man being for one year at $3.66, an estimate which would be by no means too great if all persons were grown people. As this is not the case, it reduces itself, according to the tables of Rœderer and Eichhorn to about 34 cents for the fæces and $2.75 for the urine, or $3.09 in all.

If we now take into consideration the statements made above in relation to the loss of fæces and urine, and the loss of ammonia and sulphuretted hydrogen, the manurial value of the excreta of one human being obtained by this method of removal will certainly not exceed $1.50. If we only estimate the yearly cost of transportation per inhabitant at $1.00, certainly a low estimate for Atlanta, when the contractor receives an equivalent to it in Germany, besides the excreta free of cost, we have only 50 cts. left for manufacturing and selling, a very small amount which, to say the least, reduces the probability, that we could manufacture fertilizers out of the refuse and excreta of this city with a profit, very considerably.

This mode of removal leaves a large amount of excreta, and pricipally urine, within the borders of the city, allows those which are removed to enter into decomposition previously, causes more or less noxious effluvia to emanate from the privies, and depends entirely too much on the reliability and good will of laborers and inhabitants for systematic execution. It further establishes but a very limited protection against the pollution of the soil, water and atmosphere, and therefore is at a cost of $1.00 per head, say $30,000 for Atlanta certainly as expensive as it is deficient, and does not recommend itself by a single feature to the adoption of municipal authorities; nay its general adoption in a city with an ample water supply like Atlanta would be an unpardonable violation of the fundamental principles, which sanitary science has established in relation to the cleaning and draining of cities, and a waste of money besides, without any substantial sanitary benefit.

Besides this method of direct removal, there exists some others, which however, are only modifications of the one just considered. Different apparatuses have been constructed and brought into use, with a view: 1st, of disinfecting the excreta; and 2d, of separating the urine from the fæces and submitting the former to a process of chemical filtration in order to retain its fertilizing material and to make the remaining water innocuous.

Moules' earth closets with its many imitations, the various closet and privy constructions, Cazeneuves fosses, mobiles inodores, the divisors and separators of Dulgere, the system of Belicard and Chenaux, that of Mosselman, Blanchard and Mueller-Schuer come under this head.

All of these methods require more complicated tubs and other contrivances than direct removal. They are therefore subject to the same, and, as transportation of disinfecting material comes in as an additional item of expense, still graver objections than simple direct removal, and although they have been tested in different cities they have nowhere gained general introduction.

Some of them may be made to answer a good purpose in prisons, schools, barracks and larger agricultural establishments; but they are entirely unfit for general introduction in cities, and will never be used there only at the will and choice of individual citizens in the suburbs, where the benefits of an ample water supply and water carriage through drains and sewers cannot be obtained. Not one of them offers approachingly a solution of the most important problem of public hygiene, that of preventing pollution of the soil, water and atmosphere by the waste, percolation and decomposition of excreta and other decomposible material.

LIERNUR'S PNEUMATIC SYSTEM OF REMOVAL

has been extolled by a few as the most perfect method to collect fæcal matter in cities. It has been amply tested in different cities of Germany and Belgium, for instance, in Cassel, Hanau, Stutgardt, Leyden and Amsterdam. It is an extension of the old method of Dr. Domange, of Paris, who first thought of emptying the contents of privy sinks into large tubs from which the air had been removed by an air pump. Liernur puts a number of privies into communication with an air-tight reservoir under the surface of the street by cast-iron pipes, empties their contents into this reservoir by pneumatic pressure, and from there by the same force into a transportable one, which removes them out of the city.

That fæces can be removed in this way more completely, more speedily, and more frequently than by manual labor cannot be denied, but technical and financial difficulties attached to this method make it, like simple, direct removal, impracticable and unfit for general application in cities.

The main principle upon which the power of Liernur's apparatus depends is air-tight closure. In practice it is found very difficult to establish and maintain that in a system of pipes opening into thirty or forty different privies. The improbability of creating a pneumatic force which will operate and remove fæces farther than about three hundred feet, is also one of the great objections to this method. Outside of this limitation of the distance of working power, other circumstances, which had been entirely overlooked in the first construction of this apparatus, interfere with its practical applicability. It frequently happens that solid substances, such as broken china-ware, nails, spoons, knives, forks, rags, etc., find their way into the pipes, which accumulate and cause annoying obstructions and delay, and the most perplexing trouble to the laborers; but these substances do not only obstruct the passage of fæces in the pipes, but get every now and then between the cautchouc ball, that is intended to close the so-called ball-valve and the walls around the opening of that valve, so that the working of the apparatus is made entirely impossible until they are removed. But worst of all, it happens now and then that the cautchouc ball, intended to close that valve by pneumatic pressure, is driven into the opening of that valve with such force that it becomes difficult to remove it.

The expense of collecting and removing one load of fæces holding 1500 litres (375 gallons), accomplished by two horses and one driver to the removing apparatus, and two horses, one machinist, and one driver to the tender, is at Amsterdam six florins (about $2.50), and the average cost of fitting up one house for this method of removal is 108 florins ($45). The property holders there are very much opposed to this method of removal, on account of its expensiveness and cost, and out of 27,183 houses, only two hundred were fitted up by the first of the year 1872 for this mode of removal.

Would such a system be applicable to Atlanta? How many reservoirs would have to be built from the end of Marietta to that of Decatur street, and from the end of Peachtree to the end of Whitehall, if the feces cannot be brought to the reservoir farther than three hundred feet? About twenty to every mile of street. How many locomobiles and tenders, how many drivers, machinists, and laborers would the city have to em-

ploy to empty the privies at least once every twenty-four to forty-eight hours; and how much difficulty would we have to encounter to keep such a complicated system in good working order? I need not make the effort to answer these questions; you will all agree to a statement already made above, that this method is technically, financially, and hygienically impracticable for general application in cities.

WATER CARRIAGE,

or in other words, removal of the usual solid and liquid filth of cities—except street garbage, through properly constructed sewers, by the natural gravitation and velocity of the waste water.

The opposition to this mode of disposing of excrementitious matter has been very great, and has had its origin principally in the continued mistake of its opponents to charge the sewers of later years with all the evils and injurious properties of the old and badly constructed sewers of anti-sanitarian times, of which a great many are yet in existence, not only in Atlanta, but in many cities of this continent as well as Europe.

George Varentrapp, one of the great advocates of water closets and sewerage, and one of the first hygienic authorities of Europe, uses the following language in relation to this error:

> It is either a dishonest mode of proceeding, or, as we do not have the right nor the will to suppose this, it betokens the radical ignorance and confusion of our opponents in this matter, that we, the defenders of systmatic sewerage and water closets are continually reproached with the unfavorable experiences that have been made on the old and badly constructed sewers, with or without water closets. That what Chadwick, Arnott, Rawlinson, Lindley, and Wiebe oppose and endeavor to eradicate should indeed not be held up to them as the final object they intend to accomplish, simply because their's, as well as the old contrivance, are called sewers. Such confusion and ignorance is inadmissible in so serious and important a controversy, and has *bona fide* led not only to the expression of exaggerated fears and descriptions, but in a few instances simply to naked lies.

When our committee advocates canalization, as some have styled it, or rather sewerage with all its requirements, we need, after the above quotation, not to affirm that we mean that kind of sewerage which, comes up to all the demands of modern sanitary engineering.

*Varrentrapp. Uber Entwasserung der Stadte. Berlin, 1868. Page 118.

We need not assure you that we condemn square permeable sewers, with flat and rough bottoms, without sufficient fall, ventilation, etc., such as we mostly have here, but that we advocate sewers which receive and carry outside of the limits of the city all the refuse and surplus water from buildings of any kind, and from the surface as well as from the upper strata of the soil. They and the houses must therefore be so constructed and so connected as to be able to receive and carry all the rain, house, kitchen, and cellar water, including the fluid and solid human excreta, and the liquid offal from workshops, factories and streets. They must also drain the soil of surplus moisture, prevent the moulding of the foundation walls of buildings and the dampness of basements and cellars.

Conduits, which fulfill this object—call them what you please, sewers or drains—we recommend for Atlanta, and trust that our recommendation will not be considered unreasonable, as certainly no sensible man would think himself justifiable in blaming us for our advocacy of good sewers, any more than he would blame another one for advocating the building of a good hospital, simply because there are and have been hospitals, whose construction favors the occurrence of hospital gangrene and pyæmia. Sewers—to use my favorite term—to answer the above mentioned purposes, must have the following qualities:

1. They must receive within a certain length of time a sufficient quantity of water ($4\frac{1}{2}$ to 5 cubic feet, about 35 gallons per head daily) to set up frequently a sufficiently strong downward current to prevent any accumulation or deposit of solid substances.

2. They must have the proper size, shape, smoothness of bottom, and sufficiency of fall to create a velocity of the water current within of at least from two to three feet per second, so that through their entire length no diminution of velocity below this minimum, much less an entire cessation of motion, can take place.

Thus accumulation and stagnation of sewage, decomposition and formation of sewer gases, to any perceptible extent, are prevented, and the sewage deposited on fields long before decomposition sets in.

Good sewers are never square nor round, but elliptic, with

smooth bottom and sides, and lateral sewers always open into them, not under right, but sharp angles, in order to increase the velocity of the volume of water flowing through the receiving sewer, instead of impeding it.

3. They must be built of such material, or otherwise so constructed that their bottom and sides will not allow the sewage to escape into the surrounding soil, and must be laid down in a bed of gravel, firmly rammed down, to establish, at the same time, drainage of the soil, and in order to accomplish that to a sufficient depth, they must lay below the level of cellars and basements, generally about twelve feet under the surface of the streets.

A good system of sewerage requires, above all things, a careful topographical survey of the entire surface of the city for which it is intended. The grades of streets must be permanently established before hand, the different sewerage areas, the course and outlet of the main sewer for each one, the points of intersection with lateral sewers carefully laid down. The size, fall and depth of all sewers should also be carefully determined, according to the maximum rainfall of each sewerage area, the amount of natural and artificial matter with which it is likely to be supplied, and the number of the present and prospective population, which it will have to serve.

The construction of the ditches in which the sewers are laid down should be carefully governed by the condition of the earth through which they run, the quality of the material out of which the sewers are built, the brick, mortar and cement, etc., should be very carefully selected and inspected, and, if sewer-pipes are used, the durability of each one carefully tested.

The connections between water closets, house and kitchen sinks, etc., and the sewers into which their recipients are trained, should be most carefully constructed in conformity with the best technical rules in existence. As the sanitary efficiency of this entire method of removal depends very much upon the knowledge and care exercised in this matter, it should not be left to the penuriousness or ignorance of house owners, and contractors, as the case may be, but should be regulated by proper ordinances, and controlled by the sanitary authorities of the city, after principles hereafter to be considered in

detail, if it should become necessary. Proper water closure and ventilation of the closet pipes, as well as the sewers, with a sufficient water-supply for each house, are, of course, the leading points to be established.

If all these requirements have been properly taken into consideration and properly put into execution by an engineer, sufficiently acquainted with this kind of engineering, percolation, accumulation and stagnation of sewage, formation and escape of sewer gasses into buildings, and pollution of soil, water and atmosphere of cities, become almost an entire impossibility.

Any one who still continues to make the old charges of the insalubrity of sewers against such sewers as we have described, is simply not willing to be convinced, neither by the plainest dictates of reason, nor the plainest teachings of experience. He knows nothing about the subject and does not want to learn anything about it, and should, therefore, not claim a voice in its discussion.

COST OF SEWERS.

The well known English engineer, Rawlinson, states, from his extensive experience, that the cost of a perfect system of sewers for cities having in the neighborhood of 30,000 inhabitants, in England, does not exceed one pound sterling per head. He gives statements of the cost of the canalization of ten English cities, which was executed under his supervision, and this is the largest amount of cost in any one, while in some it did not amount to more than two-thirds, and three-fourths of that amount. At Rugby, which was sewered with heavy earthern ware pipes, the running foot of sewers there cost only two 2 shillings 1d., and, the English mile, 530 pounds; in Barnard Castle, the English foot cost only 1 shilling 8d., or 439 pounds per mile.

The cost here could, with conscientious and proper management, not exceed the cost in England but very little, and the gradual expenditure of from $180,000 to $250,000 would in all probability supply Atlanta with a good system of sewers

General direct removal all over the city to be even reasonally efficient, would at the very lowest estimate not cost the city less than $1.00 per head a year, over and above the value of the fertilizers, say $30,000, an amount which would readily pay

the yearly interest and provide for the gradual return of the cost of a system of sewers.

Thus we deem it a well established fact that the removal of all excrementitious and decomposible matter, and of all the water from the surface and the surplus moisture from within the soil, through properly constructed sewers and drains, by an ample supply of water, is not only according to the dictates of reason, but also to the teachings of experience; by far the most natural, most complete, most expeditious, most inoffensive and most economical method of removing excreta, and by far the most valuable sanitary measure ever introduced for the preservation of the health and cleanliness and reduction of the mortality of cities.

II. Is the water supply of Atlanta and the topographical condition of its surface and the geological condition of its soil, such as to offer any serious obstacles to drainage and sewerage or such that it becomes unavoidably necessary as the most effective and most economical mode of removal?

WATER WORKS.

It seems that the great necessity of an ample supply of pure water in a city has been amply appreciated here by the early construction of a system of water works. If perhaps secondary considerations, such as the scarcity of water in our city in times of fire were originally weightier reasons in the minds of a majority of the people in favor of their construction, than their inestimable hygienic value in furnishing: first water undefiled by decomposed organic matter, such as all city wells will sooner or later contain, and next such an abundance of it for all purposes of human life, that it becomes, as nature intended is to be, even in the very largest cities, the general purifier and cleanser in the household of the poorest as well as the richest and the common recipient and carrier of the entire filth of a city, it matters indeed but little. The fact is, they exist and it becomes therefore the duty of our committee to consider the influence, which their existence must unavoidably exercise in the decision of the question by what method the refuse and excreta of our city shall be removed.

A careful examination of the pond with its surroundings and the water it contains has led to the following conclusions:

THE QUALITY OF THE WATER,

if it were free of the admixture of particles of clay and mica, as drinking and cooking water, is unobjectionable. It is soft and contains no inorganic substances to such an extent as to be in any degree injurious to health. The large admixture however of the above named substances gives it a disagreeable dirty appearance, and makes it up to this time unfit for drinking, cooking and washing. That the clay and mica it contains find their way into it during heavy rains from the surface of the old fields, which almost entirely surround the pond, and also from the streams which supply it during such periods, cannot be doubted. A ditch four miles long has therefore been dug all round it, this ditch has no outlet but the pond itself, and the dirt raised in digging it has unfortunately been thrown between the ditch and the hillside, hence any heavy rain will wash more or less of it back into the ditch, and from there into the pond, an item which, when it is remembered that this bank of loose red clay is four miles long and on an average perhaps 2½ to 3 feet wide at the bottom, and from 18 inches to 2 feet high, and contains many cubic feet of our loose soil, does certainly account to a considerable extent, for the permanent turbidity of the water up to the present time.

A laudable effort to set these hillsides in Bermuda grass has been made, which, whenever a good stand of that indestructible grass has been obtained, will very materially allay this trouble. In the mean time the propriety of filling up the ditch spoken of above, might be considered by those entrusted with the care and management of the works.

To what extent the streams themselves, which supply the pond, furnish mud, is hard for us to determine. When the writer of this report examined the pond, the water running into it was perfectly clear, hence it could only be in times of rain that they carry mud. If it is found that the supply of water, in times of rain carries too much mud, the erection of catch basins with filtering dams, where the main stream enters the pond might receive the consideration of the Water Commissioners.

Many other plans could be put in operation to clear the water, for instance, the erection of a filtering bed of gravel and other material over and around the box from which the

water runs to the engine, which forces it to the city, or the digging of a channel to give the rain water from the surrounding hills as well as from the main stream during heavy rains a different direction, and keep it out of the pond while muddy. These different propositions of freeing the water from mechanical admixtures are only mentioned to show that this evil can undoubtedly be remedied by proper engineering, and that the water-works are not a failure in this respect, but can and should be so improved that the water answers all domestic and industrial purposes.

Very few works of that kind, if any, have ever been erected, but what some deficiencies existed and had to be corrected afterwards. The writer of this report, however, is much inclined to believe that, in course of this summer, and within a very short period of time, a material improvement in the quality of the water will probably take place.

The quantity of water* furnished by these works is now, and will be, fully sufficient for the largest consumption of a city of at least 50,000 inhabitants, and will furnish an ample supply to maintain a permanent flow of water in properly constructed sewers.

The present surface area of the water contained in the pond is a little over fifty, that of its bottom, about eighty, acres, and its average depth is nineteen feet. Its minimum supply per day, from the streams it receives, is 2,300,000 gallons, and its average contents are 580,000,000 gallons, in spite of a daily waste, through the escape pipe, of more water than is used in the city. Thirty-five thousand inhabitants would, at the usual rate of consumption, 35 gallons per head, need daily 1,235,000 gallons; 50,000 inhabitants, at the same rate, would need 2,500,000 gallons. These figures are arrived at with the lowest estimates in the calculation of the supply, and the highest in the estimation of permanent consumption. The supply received by rains is not taken into consideration. They show, amply, the correctness of my statement that the works are sufficient for 50,000 inhabitants. One mistake, however, has been committed in the selection of the streams which supply the pond. The branches emptying into it origi-

* I am indebted to the kindness of Mr. Wynn, Superintendent of the Water Works, for the numerical statements contained in this chapter.

nate on Whitehall street, one near Charles Baker's, east of the barracks, running down by Kries' old brewery, and another one further south, and nearer West End, on or near James White's place. This error can only be corrected by protecting these branches, as much as possible, against pollution from privies and other sources, in that portion of the city, and never allowing sewage to enter into them. With the present small population of that portion of the city, the evil is easily remedied, and can be averted, now and hereafter, by a proper sanitary control over the houses, the natural drainage of which flows into these branches.

Atlanta uses, now, about 200,000 gallons of water daily from the water works. How much more will she use after four or more miles of pipe have been laid down, and after they have existed a year or two longer, and the water has become clear and fit for drinking, cooking and washing, and has found either voluntary or involuntary introduction into all the houses in the streets where water pipes exist? And that it will come to this, is plain and unavoidable, because the privies and cesspools, as they now exist, must be abolished, and water-closets emptying into sewers, and not into street gutters, as they frequently do now, must be generally introduced. Will these hundreds of thousands of gallons running over our rough and ill-arranged gutters into our so-called sewers not contain all the filth and decomposable organic matter of the streets, kitchens, wash and bathing houses, work-shops, slaughter-houses, factories, etc., of our city, which will be as liable to decomposition and putrefaction as excreta, and will this state of things not, from year to year, more imperatively demand the construction of proper sewers and drains?

If this is the case, and if these sewers must be built, is there a single good reason why they should not at the same time, with the liquid refuse, receive the human excreta? Why should the great comfort of well constructed water-closets be denied to the citizens of Atlanta, after they have made up their minds to pay still more for sewers to carry off their water or pay a tenfold forfeit sooner or later to the apothecary, doctor, or still worse, the undertaker, besides loss in business and suffering in body and mind? Would there be any justification for establishing a separate and decidedly less

efficient system of direct removal of excreta from privies, or still worse, earth closets or excavated vaults by hand or machinery, at an additional expense to that of water works and sewers, when each citizen is compelled to use more or less water and pay for it, when the very force of that water, while running through pipes into sewers, will carry all the filth of his household at a velocity of at least two to three feet per second away from the house, hence much faster and cheaper than lazy mules and negroes, or even good horse teams can and will carry it? The good common sense of the people will certainly never allow such folly to be put into execution in Atlanta, as a substitute for sewers. Wherever water works exist sewers are an indispensable necessity. The former fulfill the first demand of public hygiene, they furnish an ample supply of unpolluted water for drinking and cooking and all the purposes of domestic life, so that the inhabitants become not only gradually independent of the well water of the city, which does now in many localities, and will everywhere in the city, sooner or later contain more or less decomposible organic matter; but have an abundance of water to maintain the utmost cleanliness in every department of the house and its surroundings. The latter, the sewers, fulfill the second and equally important demand—that all filth, refuse and excrementitious matter should immediately and speedily be removed from human habitations, and should never be allowed to accumulate within or around them, or to enter into the slightest degree of decomposition there.

Whenever the sanitary improvements and institutions of Atlanta are of such a character that they comply strictly with these two fundamental requirements of sanitary science, then we may justly claim that our city has made another great and enviable progress of which all her citizens will have a right to be proud; while all measures falling short of fulfilling these demands are only expensive makeshifts, which will be and have every where been abandoned as soon as the disproportion between their cost and their sanitary value becomes sufficiently apparent to the public mind.

TOPOGRAPHICAL CONDITION OF THE SURFACE AND GEOLOGICAL CHARACTER OF SOIL.

It is well known that the surface area occupied by Atlanta

has two main slopes, one to the west and one to the east, and that the ridge between them constitutes the dividing line between the waters of the Gulf and the Atlantic ocean; Peachtree and its continuation, Whitehall street, with exception of a deviation towards the Capitol, occupy the top of this ridge nearly their entire length. Swift running branches with excellent fall on each side of this ridge are now receiving all our surface drainage, and are the outlets of our so called sewers, which now receive the sewage of the city. These branches will necessarily determine the location and course of our future sewer mains, and we have at least five of them with as much and more fall almost everywhere during their entire length as may be desired.

The surface condition of our city, however, is not only favorable to the construction of sewer mains, but just as favorable to the construction of lateral sewers. That we have only a very few reasonably level streets in Atlanta, and very many steep ones, every one must admit. There is therefore very little probability that a topographical survey would reveal the existence of streets or portions of streets where sewers could not be supplied with more than sufficient fall.

The soil of Atlanta is the product of the metamorphic rocks of this section, principally of Gneiss. It is a red clay, containing a large proportion of the scales of mica and a considerable quantity of the oxide of iron. It is reasonably porous, tenacious enough not to require extra labor and material to support the walls of sewerage and drainage ditches, and it offers no impediment whatever to the laying of sewer pipe or construction of brick sewers.

III. Does a system of sewerage and drainage permit of the final disposition of the refuse and excreta in such a manner that they become inocuous to the surrounding country, and useful for agricultural purposes?

We answer most emphatically, Yes.

The full manurial power of organic matter and excreta of cities can only be preserved and utilized by the introduction of systematic sewerage with water closets, because a large portion of their manurial value will be lost, even by the most effective and speedy direct removal on wheels. Such removal cannot be effected from every locality every day; hence decom-

position sets in previously, and with it a large portion of ammonia and sulphureted hydrogen gas escape and are lost, an item of greater financial importance than the advocates of the different direct removal plans are willing to admit.

Water we are necessarily compelled to use extensively for our bodily wants—for drinking, washing, bathing, and cooking, and for the general purposes of the house, workshop, and factory; and it has long ago established itself beyond all doubt as the most natural, most convenient, and cheapest medium for the reception and removal of all filth from human habitations. In the same manner it is the only medium by which all these substances can again be returned to the soil in the most suitable form, provided that the entire sewage is not turned into running streams, but first used for the irrigation of properly situated fields.

IRRIGATION

has, as long as history dates back, been used in different countries for agricultural purposes, but a systematic regulation of it, in the combined interest of hygiene and agriculture, has only been commenced a few years ago.

England has taken the lead in this branch of sanitary science, and the official investigations of this subject, by highly qualified commissions, carried on through a period of eight years,* contain a great deal of valuable information, the most important points of which I beg leave to lay before you.

The gentlemen composing this commission have divided a twenty acre meadow at Rugby, put at their disposal for experimental purposes, into five four-acre fields, of which *a* is left without irrigation; *b* is irrigated yearly with 3000 tons sewage; *c* with 6000 tons; *d* with 9000 tons, etc. The sewage which they use has been chemically examined ninety-three times; also the grass, hay, milk of the cows, etc, and a large number of the most accurate tables, showing the results of these experiments, are on hand.

It is thus established that not only the theoretical, but also the actual value of sewage, is decidedly greater than that of the substances, which are generally removed by any of the different methods of direct removal.

*Third report of the Commission appointed to inquire into the best mode of distributing the sewage of towns.

The establishment of the irrigation channels and ditches occasions a moderate expense; the elevation of the sewage, where it becomes necessary, a larger outlay; both together, do, but very seldom, equal the expense of direct removal. The utilization of these substances, by irrigating comparatively small surfaces of tillable soil, has, according to the united opinion of all investigators, been the very cause of the most excellent and profitable results.

The most complete and conclusive opinion on irrigation and its results, is certainly contained in the above named official report. The final conclusions of their third report are as follows:

1. The correct manner for the utilization of the sewage water of cities, consists in its permanent employment for the irrigation of land, and only this usage can prevent the final pollution of rivers and streams.

2. The profit of such a permanent utilization of sewage changes, according to the various local conditions, because, in some localities, the irrigation can be established by natural fall, while in others more or less elevation, must be accomplished by pumping; and, again, because a heavy soil is less susceptible to this mode of fertilization than a light soil.

3. When local conditions are favorable, and where, thereby, unusual expenses can be avoided, the cities can realize a profit by this mode of using sewage water. Under less favorable conditions, an equalization of expense and income becomes impossible, but, even in the worst instances, a very moderate taxation will generally suffice to cover the loss.

The latest report of the same commission contains, in short, about the following points of information:

"Sewerage is an indispensable necessity for every large community. The only difficulty connected with it consists in the proper utilization of the sewage in such a manner that neither the streams nor the air are contaminated. Disinfection and filtration do not answer the purpose. They have been tested in every possible way, but without success. Disinfectants do not disinfect sewage water, filters do not filter it, and all efforts in this direction have been costly failures.

"The odor of fresh sewage fluid from proper sewers in the open atmosphere is hardly perceptible, and when spread in that condition over a sufficient area of land, it runs off clear, tasteless and inodorous. When used in this manner, irrigation, establishes itself as that mode of utilization of sewage, which yields the greatest amount of benefit to the soil, and the least damage to running water. It may be difficult, in a few instances to find suitable land for this kind of irrigation; but it seems that no kind of soil from the lightest drift sand of Edinborough to the heaviest clay of East Norwood, is unadapted to improvement in this manner, and for the cleansing of sewage heavy clay seems better adapted than lighter soils.

The process can be continued day and night, summer and winter, in wet and dry weather.

This report of the English Commissioners on this subject in its final conclusions, calls attention to the following points as important considerations in relation to this mode of disposing of sewage:

1. The irrigated fields must be at least one mile distant from the city, and situated in a northern or eastern direction if possible.

2. Their area must not be smaller than in the proportion of one acre to the sewerage from 150 people.

3. The open ditches must be so constructed as to retain as little of the sewage fluid as possible.

4. The land must be so arranged that a sufficient quantity is kept in readiness for irrigation every day.

In the seventh volume of the Viertee Yahrs Schrift fuer œffentliche Gesundheitspflege (Quarterly for the cultivation of public health,) 1875, we find different reports and articles on the extensive experiments made at Dantzig, Breslau, Paris and other places, where sewage is used for the irrigation of market gardens and crops of all kind and even fruit and forest trees.

We have not had time yet to give these lengthy and detailed articles a full perusal, but find nowhere any condemnation, but only a very decided corroboratian of the above made statements in relation to sewage and irrigation.

As Liebig has so often been quoted by the opponents of sewerage and irrigation, I deem it proper here to add two letters of his, one to Varrantrapp, and one to the Lord Mayor of London, in confirmation of the views expressed on these subjects in this report:

MUNICH, May 1, 1866.

My Highly Esteemed Doctor:

In reply to your esteemed favor of the 25th of April, I state to you that I have often conversed with Mr. Lindley during his stay in Munich last fall, about his plan of sewering Frankfort, and that I do fully agree with him in all principal points. I am of the opinion that amongst the present modes of removal that one which is based upon an ample water supply (about six cubic feet to the head,) is the safest and cheapest method for the removal of all filth contained in the house and street water, and I have expressed myself in that sense to the city of London, when my opinion was desired on that subject.

For the health of the inhabitants of a city and for public cleanliness, it is all important that all filth should be removed fresh and before it enters decomposition and putrefaction. The escape of noxious gases from

sewers into houses must as a matter of course be still prevented by water closure.

For the purposes of agriculture it is of peculiar value that the contents of sewers are not emptied into water courses, but used for fertilization. The profitability of this method, particularly in the irrigation of large extents of meadow lands is generally acknowledged in England. I am convinced that in course of time the contents of sewers used in this manner will be a source of considerable income to the city.

In this I believe all the questions about which you desired my opinion are announced.

Permit me to express the high esteem with which I am

Your devoted,

JUSTUS VON LIEBIG.

The same authority, wrote on the 19th of January, 1865, an open letter to the Lord Mayor of London, which has been published in the English papers containing the following passage:

Fifteen years ago, before the manure absorbing quality of the soil was known, hardly any body would have thought of using sewage water for the fertilization of fields, and the immense dilution would have been considered a great objection. Now, when we know that this great dilution has no influence in preventing the accumulation of manurial substances we consider this very circumstance the most needful condition in order to make the excreta of men and animals in cities useful for the field, because, only in this condition they can be properly moved by machinery to the places where they are to be used.

Now I speak again of Atlanta. Where and how far from the city, fields suitable for this object could be found, we do not yet know. Close local inspection and survey would have to establish these localities, and the fact that the country descends in most every direction around Atlanta, justifies the presumption that it will not be difficult to do so.

When it comes to a consideration of the necessity of this purification of the sewage of our city by the irrigation of fields, I am confident that the pollution of the branches which receive it would be so inconsiderable for a number of years to come, that an urgent necessity for it would not arise immediately, nay, I am even of the opinion that with proper sewers amply flooded with water, their pollution would be less than it is now, because no excreta and offal would be allowed to accumulate and decompose any where within the bottom of good sewers; they would become mixed with a much larger quantity of water and reach the outlet of the sewers much quicker than they do now, or in other words, the sewage of Atlanta

would be, as it is everywhere else, where self-cleansing sewers and ample water supply exist, perfectly fresh, almost inodorous and inoffensive.

Sewage in this condition is not damaging to fish, because fresh excreta contained in water in moderate quantities are eagerly sought after and devoured by them, while, when already in a state of decomposition, they are carefully avoided. The reports of Husband, Rawlinson and Lancaster, establish these facts without doubt. They all agree further, that a small amount of very putrid sewage exhausts the oxygen of the water much quicker than a very large quantity of fresh sewage, in which the very small particles of organic matter are readily oxydized by the oxygen of the water, which being mixed in sufficient quantity with them can continue to draw a fresh supply of oxygen from the atmosphere.

These facts we trust are sufficient to show that water carriage permits finally of a more useful and profitable utilization and more successful perification of sewage than any direct method of removal of offal, excreta, etc.

We finally propose the following conclusions for your consideration:

1. The present location and condition of many privies, and the mode of disposing of their contents by burying them in the earth within our residence lots near our houses and wells, and the fact that the liquid waste and filth of houses, kitchens, etc., and the contents of water-closets, are allowed to accumulate and stagnate round about dwellings, or, at best, in the street gutters in many localities, is a gross violation of the first demands of sanitary science and public decency, and calls for early reparation.

2. The street gutters and so-called sewers of the city, as they now exist, do neither prevent accumulation and stagnation of liquid, much less solid filth within them, nor percolation of the liquid waste into the soil and wells of the city. They are therefore an injury to the health of the inhabitants, and will become more and more deleterious and objectionable with the increase of the consumption of the water furnished by the water-works.

3. With this increase of consumption, the amount of the liquid waste and slop waters from dwellings, store-houses,

work-shops, and factories will also increase, and the water, after it has been used for cooking, washing, bathing, and scouring, and has received the filth and offal from tanneries, butcher-shops, slaughter-houses, provision-stores, bakeries, dye-houses, and work-shops of all kinds, the filth and horse manure from the streets, the rich contents of hundreds of slop buckets of second and third stories of houses, either without any, or only with very inconvenient or uninviting privies, is and would be considered by most people, even if repeated chemical analyses had not fully established the fact, nearly as richly supplied with organic and decomposable matter as if it contained the urine and fæces from the privies and water-closets in addition; and is therefore impure enough to contaminate and pollute the soil and water of a city, and must not be allowed to diffuse itself over the surface, or soak into the soil, or find its way into insufficient and permeable sewers, as is the case here, but must be carefully confined and directed into good sewers, and carried beyond the city limits before it begins to decompose.

The deleterious and offensive character which this liquid waste—if it were allowed to remain any length of time in tanks, cess pools, or street gutters—would assume, and its immense quantity, exclude, almost *a priori*, the possibility of removing it effectively for sanitary purposes any other way but automatically by the force of gravitation, in properly constructed sewers, which allow no accumulation or stagnation. Hence sewers are an indispensible necessity for Atlanta, even if the water-closet system and its connection with the sewers should not be introduced, and the urine and excreta should be prevented from entering them.

4. The quantity and quality of the liquid waste of Atlanta, or any other city with water-works, which the sewers will receive and carry, will respectively not be increased or deteriorated but a very small fractional part by the reception of diluted urine and excreta from water-closets, and therefore no changes in their dimensions or material, and no increase of cost whatever will be occasioned by water-closet connection and reception of their contents by sewers.

The general introduction and connection of water-closets with sewers, therefore, recommends itself more pressingly to all modern cities.

a. Because it can be accomplished without any cost whatever outside of that of the closets and sewer connections, while any other method whatever would require the same, or a larger expense for local fixtures to-wit: closets, excavated and cemented tanks, hose, and would, besides, be connected with a permanent and considerable expense to the city as well as to the house owners without removing either solid, much less liquid waste, completely or in due time, to-wit: before decomposition.

b. Because it is the only method by which a final abolition of tanks and cesspools, or any other receptacles for the reception and accumulation of excrementitious substances, under or near human dwellings, with their unavoidable pollution of the soil, water and atmosphere can be abolished.

This pollution is unavoidable, because, according to long experience in Europe, tanks and cesspools of the best mechanical construction will corrode under the influence of the products of the continued putrid fermentation of urine and fæces, and therefore excrementitious substances will find their way into the soil, and because none of the laborious and expensive methods of direct removal of their contents either by manual labor or machinery (pneumatic pumps, etc.,) empties them so entirely and so often as it is necessary to prevent putrid fermentation, development of noxious gasses, offensive odors, retention of filth within or round about them.

c. Because without this connection of water-closets with sewers the water-closets already in existence in many private and almost all the public buildings of the city would have to be abolished by force of law, or, in other words, a retrogade step would have to be legally sanctioned; filth would have to supercede cleanliness and comfort, and a measure containing within itself a violation of common sense and sanitary principles, and a great injustice to the tax payers, house owners, and the people at large, would have to be forcibly initiated. Tax payers and house owners, in spite of the fact that water is the most natural and therefore the most effective and cheapest medium to remove filth and to keep ourselves and things round us clean, would have to be limited by law in the use of this water after paying for it, and for its conveyance to their houses, and after being taxed yearly for the erection and—if such measures should prevail—not without being hereafter taxed for the maintenance of the works which supply it. Thus, in order to establish a method of direct removal of excreta independent of sewerage, which, to say the best of it, is only of very doubtful sanitary value in communities with an ample water supply, they would have to be forced to the additional expense of erecting cemented privy vaults in their houses, and to permanent expense or taxation for this imperfect removal.

European experience has shown that in spite of stringent sanitary enactments water-closets cannot be kept out of cities with water-works any length of time. If this is true there, it will prove to be much more

so here, where public opinion would soon crush such an unnecessary and unjustifiable encroachment upon the plain rights of the people.

e. Because, by this automatic, immediate and speedy removal of human excreta, the pollution of the soil, atmosphere and water, and the accumulation of excrementitious, or other organic material about human dwellings is almost entirely prevented, or at least reduced much more emphatically to a minimum than by any other method whatsoever without any additional cost, besides that of the sewers, which are unavoidably required for the removal of liquid wastes, and without which the water-works will gradually become a financial burden and a sanitary evil to the city.

f. Because this—the water carriage mode of removal—does not only do full justice to the sanitary wants of the city, but also to the interests of agriculture and national economy, as it is a fact, established beyond all doubt, that sewage from modern sewers, with ample water supply, can be purified and made entirely inocuous by being understandingly used for the irrigation and fertilization of fields. Thus the much feared pollution of the brooks and streams into which it empties can be prevented, and it can probably be made a source of profit to the city with perfect certainty of doing no harm, sanitarily or otherwise, to the surrounding country.

5. Therefore we conclude finally, *that an ample supply of water by water works connected with proper sewers are the most economical and surest means to remove refuse and excreta, and make them not only inoffensive to the health of the city and country, but useful to both.*

We therefore recommend:

I. A careful typographical survey of the city for the purpose of establishing a permanent plan for its drainage and sewerage, and the utilization and purification of its sewage by the irrigation of fields in the proximity of the city, in due time. This plan shall contain exact statements in relation to all the details, as to the shape, size, material, fall, depth, etc., of each sewer as alluded to in the chapter on water carriage, of the above report, also specifications of cost, etc., and shall be accompanied by a map of this system in the proportion of one foot square to each square mile of the sewered territory.

II. A careful inspection and approval of this plan by competent judges.

III. Its gradual execution by competent engineers *as far as the water supply of the city extends*, and as fast as the necessities of the houses using water from the water-works demand it, and the financial ability of the city permits it.

IV. The construction of good surface drains and sewer mains at the earliest possible day, commencing with those which drain the most populous, the lowest and least healthy portions of the city, for instance the center of the city around the neighborhood of the Kimball House through Pryor street.

V. The passage of laws and ordinances by the proper authorities, regulating the general introduction and use of the water, sewers and water-closet connections, and establishing principles for the equitable and just distribution of taxation occasioned thereby. Only a competent committee of sanitary officers, engineers and lawyers, could succeed in doing this requirement justice.

VI. For denser portions of the city not supplied with water, and likely to remain without it some time, we recommend Dr. Goldsmith's method of removal of excreta and urine by pneumatic apparatus from excavated privy vaults at regular intervals, if the aggregate wealth of their population justifies the cost of this mode, or otherwise the systematic direct removal of privy or privy earth closet pails or both.

VII. The regulation of the location of all privies in relation to the surrounding wells. All privies should be easily accessible from without, and should be situated the farthest possible distance from wells, in the direction in which the soil strata declines from the well.

VIII. The abolition of all privies, which are not erected on a well cemented sufficiently thick, brick foundation, of definite shape and size, and on walls all around, not exceeding six inches high, of the same material, the bottom surface slightly inclining towards one or more openings at the outside wall of this foundation which can be closed with a plate of sheet iron so as to permit regular easy removal of its contents sufficiently often to prevent overflow and waste. These two last propositions deserve, because they can be much more readily accomplished, than any of the others, *the immediate attention of the city authorities.*

IX. The passage of an ordinance which makes it obligatory for the owners of such premises to clean them often enough to prevent overflow, and to use their contents either as manure in their own gardens or to have them removed outside of the limits of the city, to places of deposit established and con-

trolled by the city authorities, with police surveillance sufficient to prevent violations of this ordinance to the greatest possible extent.

X. The passage of a law by the Legislature making it a penal offence for any one in the county of Fulton to haul on wheels and deposit privy contents, or other putrid material and offal, into a running stream, or anywhere on ground so situated that it will naturally be washed into a stream or water course of any kind.

CH. RAUSCHENBERG, M.D.,
Chairman Committee on Sewers and Drains.

Mr. H. T. McDaniel, City Engineer, read the following communication.

To the Sanitary Commission:

GENTLEMEN: In addition to the brief report made by me of a plan of sewerage for Atlanta, which has been referred to you, I submit the following:

1st. That water sewerage is admitted to be necessary *by all.*

2d. That the water sewerage in cities is as impure without water-closet connections as with them; owing to general gutter and other filth unavoidably entering; consequently the pollution of streams is bound to be dealt with as a fact; and can be done effectually and satisfactorily.

3d. It can be utilized as a manure by precipitating the solids in tanks at the termini, or by irrigating lands.

4th. The sanitary results and a sketch of sewerage in ancient times.

Prof. Way analyzed the surface drainage water of the principal streets of London, before it reached the sewers, and found it quite as impure as any sewage; as shown in the following tables, Nos. 1 and 2:

Table No. 1, *Showing the Analysis of Street Water.*

No. of Bottle.	Name of Street.	Quality of Paving.	Quality of Traffic.	Residue in an Imperial Gallon.		
				Soluble.	Insoluble.	Both.
				Grains.	Grains.	Grs.
1	Duke St. Manchester Square	Macadamized	Middling	92.80	105.95	198.75
7	Foley St., (upper part)	Macadamized	Little	95.30	116.30	211.43
5	Gower Street	Granite	Middling	126.00	168.30	294.30
12	Norton Street, [canal	Granite	Little	123.87	3.00	126.87
3	Hampstead Road, (above the	Ballasted	Great	96.00	84.00	180.00
4	Ferdinand Street	Ballasted	Middling	44.00	48.30	92.30
2	Ferdinand Place	Ballasted,	Little	50.80	34.30	85.10
10	Oxford Street	Granite	Great	276.23	537.10	813.33
6	Oxford Street	Macadamized	Great	194.62	390.30	584.92
11	Oxford Street	Wood	Great	34.00	5.00	39.00

Table No. 2, Showing the Analysis of the Soluble Matter in Different Specimens of Street Drainage Water.

	Grains in an Imperial Gallon.			
	Great Traffic.		Little Traffic.	
	Granite, No. 10.	Macadam, No. 6.	Granite, No. 12.*	Macadam, No. 7.
Water of Combination and some Soluble Organic Matter	77.56	29.09	22.72	13.73
Silica	0.51	2.81	.....	.....
Carbonic Acid	15.84	12.23	None.	None.
Sulphuric Acid	36.49	38.23	46.48	34.08
Lime	6.65	13.38	25.90	16.10
Magnesia	None.	23.51	Trace.	3.50
Oxide of Iron and Alumina, with a little Phosphate of Lime	2.58	1.25	.....	.....
Chloride of Potassium	None.	10.99	None.	2.79
Chloride of Sodium	53.84	44.88	18.44	19.70
Potash	82.76	18.27	8.75	5.23
Soda	.....	.....	1.58	.....
	276.23	194.62	123.87	95.13

Baldwin Latham, C. E., says: "Many persons oppose the introduction of water-closets on the ground of the pollution of the streams of the country. A very slight amount of investigation will show that the sewage of the northern towns of England, in which midden-steads are generally adopted, is, as a general rule, quite as impure, and nearly as great in volume, as in districts in which water-closets are universally used, while, at the same time, the sewage contains nearly as large an amount of putrescent organic matter as in a water-closet town."

The Rivers Commissioners of England have given the following table showing the result of the examination of a large number of midden-stead and water-closet towns.

Showing the composition of the sewage of towns in parts per 100,000:

	Total solid matter in solution.	Organic Carbon.	Organic nitrogen.	Ammonia.	Total combined nitrogen.	Chlorine.	Suspended Matters.		
							Mineral.	Organic.	Total.
Average Midden Towns...	82.4	4.181	1.975	5.435	6.451	11.54	17.81	21.30	39.11
Average water closet towns	72.2	4.696	2.205	6.703	7.728	10.66	24.18	20.51	44.69

The excess of chlorine in the sewage of a midden-stead town shows that there is a larger proportion of urine present

in a given volume of sewage than is found in a water-closet town.

The River Commissioners also found that the case is not substantially altered where earth closets are used. They say: "The sewage from Broadmoor Lunatic Asylum, in which these closets are partially used, exhibits no exceptional degree of weakness," and they conclude by saying: "It seems hopeless, therefore, to anticipate any substantial reduction of sewage pollution with solid excrementitious matters only." The introduction of water-closets does not materially increase the volume of sewage besides.

It is no longer an experiment that sewage can be precipitated in the reservoirs at the termini by lime, and there is no noxious odor arising from it, and the water will run off pure and clear. In an elaborate report by Thomas Wicksteed, C. E., made to the Commissioners of Sewers, a successful operation of reservoirs at Leicester, England, is recorded, both financially and sanitarily. Atlanta is most favorably situated for either tanks or irrigation as modes of utilizing sewage, for, by the system proposed by me, the water supply is reduced to the minimum, giving more valuable manure, in a given quantity, than the same amount of sewage in most places, thereby cheapening the cost of precipitation. Dantzic is a notable example of practical and successful irrigation. During the construction of a system of sewers for Atlanta ample time will be given to settle on the best plan of utilizing the sewage, as my system is adapted to either.

Baldwin Latham, C. E., gives the following results in twelve towns, from the records collected by the medical officers of the Privy Council, in the ninth report of the department. In examining the table, he says, it will be seen that in some cases the actual saving in health has not been great. For example, at Rugby.

This may be accounted for from the fact that it is far more difficult to reduce the death-rate in a healthy district and make it more healthy, than it is to reduce an unhealthy district and make it comparatively healthy. It will be seen that, in the case of Rugby, before the prosecution of the works the rate of mortality was comparatively low.

Since the completion of these works, even that low rate of

mortality has improved, while those particular diseases which are attributable to sanitary neglect have considerably declined.

Name of Place.	Population in 1861.	Average Mortality before Construction of Sewers, per 1,000.	Average Mortality per 1000 since Completion of Works.	Saving of Life, per cent	Reduction of Typhoid Fever, Rate per cent.	Reduction of Phthisis, per cent.
Banbury.....	10,238	23.4	20.5	12½	48	41
Cardiff.....	32,954	33 2	22.6	32	40	17
Croydon.....	30,229	23.7	18.6	22	63	17
Dover.....	23.108	22.6	20.9	7	36	20
Ely	7,847	23.9	20.5	14	56	47
Leicester.....	68,056	26.4	25.2	4½	48	32
Macclesfield	24,475	29.8	23.7	20	48	31
Merthyr.....	52,778	33.2	26.2	18	60	11
Newport.....	24,756	31.8	21.6	32	36	32
Rugby.....	7,818	19.1	18 6	2½	10	43
Salisbury	9,030	27.5	21.9	20	75	49
Warwick.....	10,570	22.7	21.0	7½	52	19

Dr. Johnson says: "To preserve health is a moral and religious duty; for health is the basis of all social virtues. We can be useful no longer than we are well."

Works of water supply, sewerage, and temples of health, were constructed in all the ancient cities of the world. Many of these works have outlived the destruction which has doomed more imposing but less useful structures. Alexandria, Carthage, Herculaneum, Jerusalem, Nineveh, Rome, and many others had a complete system of sewers and water-works. In Rome, after the lapse of twenty-five centuries, the cloaca, constructed when she was in her meridian of power, is still retained, and performs a similar duty for modern Rome. Many works executed at that period were so stupenduous as to rival those of the present day, and they bear the strongest evidence of the clear knowledge of the sanitary appliances required for every large and populous city.

Under the Mosaic dispensation sanitary laws were religiously observed, hence the discoveries in ancient Jerusalem in modern time are full of interest. Those works show that the Jews possessed a clear knowledge of the necessity of removing all decomposing matter, as expeditiously as possible, to a place outside their city, and that they knew then how to dispose of it. Dr. Whitty, of England, in his excellent work "On the Water Supply and Sewerage of Jerusalem," says that "Euse-

bius, who was a native of Palestine, and died there about the year 340," thus quotes Timocrates, the surveyor of Syria, who stated of Jerusalem: "The whole city flowed with water, so that even the gardens were irrigated by those overflowing waters out of the city." He quotes from a paper by Rev. George Williams, B. D., senior fellow of King's College, Cambridge, upon recent discoveries of Dr. Pierotti, saying: "The situation of the Temple appears to be fixed, beyond all possibility of doubt, by the recent discovery, by Signor Pierotti, of the complete water system connected with the Hebrew Temple, still existing as entire as when it was in daily use during the period of the Jewish Commonwealth. The perfect preservation of this complicated system of aqueducts, drains and reservoirs is owing to the fact that they are excavated in the solid rock, and therefore have not been affected by the demolition by the structures above, except in so far as they may have become partially blocked up by the accidental falling in of the debris of the ruined buildings."

"Had history been silent on the subject, yet we should have been forced to conclude that there was a very complete system of sewerage connected with the Temple, introducing a large quantity of water to dilute the blood, which would otherwise have a tendency to coagulate, and carrying off the blood and offal from the sacred precincts." This, history tells us, was actually the case, and the supply of water was so managed as to flush the whole court, and carry off the blood of the numerous sacrifices. "The drains leading from the Temple, and probably from the city, discharged into a pit, which is now called the 'Fountain of the Virgin,' and which communicates by means of a channel in the rock, with another pit now traditionally called the 'Pool of Siloam,' but which there is every evidence to show is not the true 'Pool of Siloam.'"

"It is a necessary consequence of the Fountain of the Virgin having been originally a cesspool, if that be admitted a fact incapable of being controverted, that the Pool of Siloam (now so-called) was likewise a cesspool, formed for the purpose of receiving the liquor from the upper cesspool, in order that the manure in it might become sufficiently desicated to be in a fit state for removal by the gardeners who purchased it, and that the tunnelled conduit was that through which the mois-

ture was drained off into the lower cesspool, or liquid manure tank." We find from the Mishna: "There was a certain cave beneath the altar whereby filth and uncleanness were carried down into the Valley of Kedron, and the gardeners paid so much money as would purchase a trespass-offering for the privilege of fertilizing their gardens with it." The liquid matter, after leaving the traditionary Pool of Siloam, was then used, as it is at the present day, for the purpose of irrigating the King's gardens. From this description of the outfall works of the sewerage of ancient Jerusalem we learn that the sewage was collected in tanks, the solid matter was removed from it and sold, and the liquid was afterwards used for the purpose of irrigation, just as it is to-day. Although these ancient examples of sanitary works were executed when art and science had reached a high degree of excellence, we come to a period in history when both art and science declined, and with them the prosecution of those sanitary works, which were of so beneficial a character; in fact, the benefits derivable from sanitary science seem to have been forgotten and ignored, and the people sunk to the lowest depths of sanitary neglect, from which the powerful voices of plague, typhus and cholera were the first to arouse them. Little more than a quarter of a century ago efforts were first made in Europe to improve the sanitary condition of the great masses of the people, and much has been accomplished.

Accompanying this hastily prepared report, I submit a map of the sewerage system of Dantzic, and regret that my business has been so pressing that I have not found time to go more into details at this time.

Respectfully submitted,

H. T. McDaniel, City Engineer.

At meeting of the Commission, May 18th, Dr. W. T. Goldsmith, chairman of committee on disposal of refuse, excreta, etc., read the following report:

REPORT "ON THE DISPOSAL OF EXCRETA, REFUSE, ETC."

BY W. T. GOLDSMITH, M.D.

Mr. President and Gentlemen of the Sanitary Commission:

The committee "on the disposal of excreta, refuse, etc.," submit the following report. It will be necessary, at the outset, to call the attention of the Commission to the

DANGER OF FILTH TO HUMAN LIFE.

Filth is a comprehensive term. It includes all sources of rottenness, whether from animal or vegetable decomposition, as well as the refuse of manufacturing establishments. Civilized life has not yet reached the point of correct living; yet much has been done in this direction. Under the impulse of sanitary science the longevity of the human race has been greatly lengthened. For example, in Rome, three hundred years after Christ, the average duration of life among the best classes was thirty years. Now, among the same classes, the average has been lengthened to fifty years. In Geneva, in the 16th century, the average was only twenty-one. In the present century the average is over forty. In England the difference is still more striking. In London two hundred years ago, with a population of about 500,000, forty-two out of every thousand died every year, while with a present population of 4,000,000, only twenty-two die out of every thousand. A similar improvement is noticeable in Paris, even within the past thirty years. Thus during the past two centuries the advance of science, in its influence upon civilized life, has more than doubled the duration of human life. It has revolutionized the dress, habits, and diet of people; it has changed the construction of houses and cities; it has introduced better sanitary regulations, banished, to a great extent, destructive epidemic diseases, and mitigated the severity of deadly maladies. There is still much to be accomplished.

Filth, solid and liquid, is among the deadliest foes to the human race. It is destructive to life by its accumulation in and around our places of habitation, and by negligence and carelessness in removing it promptly from our midst. Its destructive influences are propagated by air and water. That solid and liquid filth (especially excremental filth) cause disease, is a fact undisputed. Dr. John Simon says:

"Filth kills in two ways. First, and most obviously, by a direct poisoning action, as when one succumbs to the concentrated fumes of organic decomposition, from an old, unventilated cess-pool, or a long-blocked sewer, or when the vigor of life is depressed by continuous breathing of a foul atmosphere, in which the fetid gases have been largely diluted;*

*Major General Cotton, C. S. I., on this subject remarks: "I am induced to insist upon this never-ceasing loss of vigor from impure air, as it comes directly home to every one at all times; since it appears to me that the reports of occasional visitations from typhoid fever or diphtheria only stagger people for a moment, and being too terrible to

second, with far greater and more subtle destructiveness by means of the morbific ferments or contagia which it breeds or harbors. And it is of the utmost practical importance to recognize, in regard to filth, that agents which destroy its odor may yet leave all its main powers of disease production undiminished. On the other hand, there may be prevalent fetid gases of the most sickening potency, with an entire absence of septic ferment in the air. Indeed, filth ferments show no power of active diffusion in dry air. They may be passively wafted for short distances, but probably do not carry their vitality far if the air be freely open. Moisture is their normal medium. Currents of humid air, as from sewers and drains, lift them in full effectiveness; and if into houses or confined exterior spaces, the chances are that their morbific powers will be less preserved. Ill-ventilated and low-lying localities, where refuse is allowed to lie, may especially be expected to have these ferments present in their common atmosphere, as well as teeming in their soil and ground water."

Organic matter, under putrefactive changes, produces those diseases classed by sanitarians, zymotic. These diseases constitute a very large percentage of deaths in all cities. In the report of the Sanitary Commission of Boston for 1875, it is stated that "eight of these diseases, namely, small-pox, scarlet fever, measles, cerebro-spinal meningitis, whooping cough, diphtheria, typhoid fever, and diarrhœal diseases, have together caused during the last ten years over a quarter of the deaths in Boston.

In thirteen of the large towns of Great Britain (notwithstanding recent sanitary improvements), nearly one-fifth of the whole number of deaths was caused by zymotic diseases. During five years past, in Ireland alone, five of these diseases have destroyed nearly 60,000 lives. The number of deaths from zymotic diseases in Philadelphia—one of the healthiest cities in the world—during 1873, was 1.550, or 11.25 per cent. of the whole mortality.

"The researches of Dr. B. Sanderson, and others, have clearly shown that in the common septic ferments, so-called, or in some ferment or ferments not hitherto to be separated from it, there resides powers of disease production as positive as those which reside in variolus or syphilitic contagia. By successive innoculations, it not only develops itself as one of the most tremendous of zymotic poisons, but becomes communicable from the sick to the healthy, producing diseases exactly corresponding to

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dwell upon; they do no more to correct the defects in our sanitary system than public executions do to lessen the amount of crime. In the depression which results from living in an impure air, all our functions are crippled, and we have none of that elasticity to throw off disease which we have when in perfect vigor. Like the weakly plant, the blight can take possession of us unresisted."

the fatal infections, chiefly known under the names of erysipelas, pyæmia, septicæmia and puerpural fever; infections sometimes arising in unquestionable dependence on filth, yet becoming, when arisen, the most communicable of diseases."

Putrescent refuse matter, as a poison, assails the human body through the lungs and stomach. The poisonous gases and disease germs arising from accumulations of decomposing refuse, whether emanating from sinks, sewers or stagnant streams into which it may be poured, become inducive of zymatic diseases. In a late work on epidemic cholera the author remarks:

It has been shown that privies, cesspools and sewers, the receptacles of human excrement, and other forms of filth, become hot-beds for the dissemination of the cholera infection. It has been further shown that the effluvia from such localities is impregnated with decomposing organic matter, and when inhaled, this organic matter becomes mixed with the saliva, is swallowed, and the disease is reproduced.

Water polluted by these matters, and especially sewage—excrementitious refuse—when continuously used for either drinking or cooking, surely and certainly prepare a population using water so polluted for malignant and destructive epidemic diseases, such as typhoid fever, diphtheria, scarlet fever, measles, diarrhœa, cholera, etc. Epidemics of typhoid fever have occurred, due to both these causes—the pollution of the atmosphere and the drinking water. * The same writer remarks:

If a privy vault should be close to a well, or if a house or other drain should pass in its immediate vicinity, the walls of that well should be rigidly and frequently examined, and water taken from the bottom of the well carefully tested, lest contaminating drainage may occur, and all wells so situated that they must inevitably receive impure drainage (sewage), or surface washings must be closed in such a manner as will absolutely prevent access to their contents.

It should be remembered that wells drain the soil in which

* "When decayed organic matter," says Mr. Adam Scott, "is discharged into fresh water, decomposition goes on rapidly, by reason of the oxygen in the water, and putrefaction sets in." This oxidation goes on far more rapidly when organic matter is thrown in fresh water than in sea water; and yet the fearful contamination of the atmosphere and consequent epidemics by pollution of sea water near cities is well known. Notwithstanding the rapid oxidation of decayed organic matter in fresh water, it has been asserted by writers in our city press that the water of our rivulets will purify and disinfect sewage, and prevent decomposition. The error of such an opinion is shown by the above.

they are sunk to a distance of not less than thirty feet in all directions around them. The English Rivers Pollution Commission of 1868 says:

> No process has yet been devised of cleansing surface water once contaminated with sewage, so as to make it safe for drinking.

The poison contained in water contaminated by sewage is fatal to life, not only by inducing immediate diseases, but by its slow impairment of the health of persons using such water. The Massachusetts State Board of Health says:

> It is to be remembered that the poison, however trifling, is taken daily, and that, although when in robust health, the individual will not suffer from it, it may be sufficient to make itself felt when he is prostrated by sickness from any cause, and his powers of resistance to such influences are then proportionally impaired.

ANALYSIS OF DRINKING WATER.

Analyses for the purpose of ascertaining the amount of organic impurities contained in drinking water, have never been accurate, and have only aproximately become so within a recent period of time. It is easy to detect sewage when the per cent. is large in water, but it is impossible to detect, by any test, the existence of zymotic poison—the disease producing cause—in water. Therefore all conclusions drawn from anlysis attempting to show the amount of organic matter in sewage water or drinking water, is of no service in deciding the existence of that kind or quantity of organic matter upon which disease production depends. Prof. Frankland, of the English Rivers Pollution Commission, remarks: "The two chief objects to be kept in view in the analysis of portable water are, firstly, the discovery of the evidence of past pollution by organic matter; and secondly: the quantitative determination of present or actual organic impurity. The past history of a water is made out chiefly through the mineral products or oxidation which the polluting organic matters have yielded, and which are still present in the water. As these products are innocuous, it is obvious that if all kinds of organic matter behaved alike under the influence of oxidizing agents, such evidence of previous pollution might be disregarded; but it is almost superfluous to point out that there are wide differences between various kinds of organic matter in regard to the rapidity with which they combine with oxygen, and of all kinds,

that which is organized and living, opposes by far the greatest obstacles to oxidation. Now the researches of Chauveau, Burdon, Sanderson, Klein and others, scarcely leave room to doubt that the specific poison of the so-called zymotic diseases consist of organized and living organic matter, and it is now certain that water is the medium through which some, at least, of these diseases are propagated.* It is evident therefore that an amount of exposure to oxidizing influences which may resolve the dead organic matters present in water into innocuous mineral compounds, may and probably will, fail to affect those constituents which are endowed with life." Dr. Frankland adduces as a striking instance of the persistency of the typhoid poison when diffused in water, "the outbreak of a violent epidemic of typhoid fever in a Swiss village through the use of spring water which, after contamination with the poison, had filtered through nearly a mile of porous earth, but which had nevertheless lost none of its virulent properties." As the typhoid poison is always liable to be present in sewage, and as there is no test for it, except its effects upon man, the discovery of previous sewage contamination in portable water ought to be one of the chief objects of the analyst.

* "It should be noted that the facts which have been put together by the most able and experienced pathologists tend to show that the contagion of typhoid fever is due to a specific and living organism, which, when transmitted from a diseased to a healthy individual, produces the same disease in the latter; and further, that the chief, if not the only vehicles of poison are the ejecta of the bowels of an infected person." Dr. Klein has recently made investigations with the stools of typhoid fever patients, and the microscopical appearances which they present are described by him. From these investigations, having localized "spherical micrococci" in the evacuations and in the mucus membrane of the ileum, he is satisfied of "*the indentity of the contagion of enteric typhoid fever with a low vegetable organism.*"

Now this fungus, or "specific mildew," as it has been called, may and doubtless does, find sustenance for its development, growth and fructification in other organic filth than that of human excrement. Numerous well attested facts would seem to establish the truth of this proposition. It is nevertheless true that "the ejecta from the bowels of an infected person"—it matters not from what filth-matter such person may have received into his system the germs of the "specific" fungus—is the prolific source of the propagation of typhoid fever.

* It has been asserted that cows drinking sewage water transmit diseased germs to persons using the milk of such cows. If this be true, the five rivulets into which the sewage of Atlanta is discharged may from this cause become dangerous sources of disease to our people.

The actual or present, as distinguised from the past, polluting organic matter of portable water can only be ascertained from the amount of carbon and nitrogen found as constituents of the organic matter present in the water at the time when the analysis was made.

POLLUTION OF THE ATMOSPHERE.

Prof. Frankland, in a recent report made to the Royal Society, makes the following statements:

The suspension of vast aggregate quantities of solid and liquid particles in our atmosphere is the subject of daily remark. Cloud, fog, and smoke consist of such particles, and I have repeatedly seen, at a distance of a few feet, abundance of snow crystals floating in the air, when the atmosphere was apparently perfectly clear and cloudless, by placing the eye in shadow and looking into the sunshine.

Professor Tyndall has, I conceive, proved that a very large proportion of the suspended particles in the London atmosphere consist of water and other volatile liquid or solid matter, by showing that the heat of boiling water is sufficient to dissipate them. That this is the true explanation of the disappearance of such particles by the application of a moderate degree of heat, and that it is not caused by the rarefied air from the heated body ascending and leaving behind the suspended matter, as suggested by Tyndall, is, I think, conclusively proved by experiments in which I found that suspended particles of sal ammoniac subsided in an atmosphere of hydrogen scarcely twice as fast as in atmospheric air.

Thus an atmosphere fourteen times as rare as that of London (and, as Professor Stokes remarked, possessing only half the viscosity of air), still offers sufficient resistance to the subsidence of minute suspended particles to prevent them from falling more rapidly than one inch per minute. Such particles could not, therefore, be left behind by an ascending current of the slightly rarefied but more viscous air produced by an increase of temperature to 100° C.

In addition to these aqueous and other volatile particles which disappear by a gentle heat, there are also others which consist partly of organic and partly of mineral matters. But the organic seem greatly to preponderate in the air of towns, because such air becomes apparently perfectly clear after it has been ignited.

The processes of fermentation, putrefaction, and decay afford abundant evidence that zymotic and other living germs are present amongst the organic portion of the suspended matters, whilst many analyses of rain water, made by myself and others, show that the salts of sea water are amongst the mineral constituents floating in the atmosphere.

Of the zymotic matters, those which produce disease in man are obviously of the greatest importance. The outbreak of Asiatic cholera in Southampton in the year 1866, for instance, was traced by the late Prof. Parkes, F.R.S., to the dispersion of infected sewage through the air. The sewage became infected by the intestinal discharges from some cholera

patients who landed from the Peninsular and Oriental Company's steamship Poonak.

In this case the dispersion was produced by the pumping of the infected sewage and its discharge, in a frothy condition, down an open channel eight or nine feet long. The effluvium disengaged from this seething stream was described as overpowering, and was bitterly complained of by the inhabitants of the adjacent clean and airy houses, amongst whom a virulent epidemic of Asiatic cholera broke out a few days after the sewage received the infected dejections. Nevertheless the discharge of the frothy liquid was kept up day and night for about a fortnight, and 107 persons perished. At length a closed iron pipe was substituted for the conduit; from that day the number of cholera cases diminished, and within a week of the protection of the conduit the epidemic was virtually over.

In this example a potent cause of the suspension of the zymotic poison in the air was obvious, but in the many alleged instances of the propagation of typhoid fever by sewer gases, the condition of dispersion is not so evident. Does the flow of sewage in a properly constructed sewer produce sufficient agitation to disperse liquid particles through the air space of the sewers? I endeavored to answer this question by violently agitating a solution of lithic chloride in a glass cylinder three inches in diameter and thirty inches high, with a wooden rod, and ascertaining whether the atmosphere at the mouth of the cylinder became impregnated with the liquid, by testing it with the flame of a Bunsen burner; but no trace of lithium could be detected at the mouth of the jar, even after an agitation much in excess of what would ordinarily occur in a sewer.*

There is, however, another kind of agitation to which sewage is subject that may produce a very different result. I allude to the development of gases during the process of fermentation and putrefaction. It is well known that the bursting of minute bubbles of gas at the surface of an effervescing liquid causes the projection of visible liquid particles into the air to the height of several inches. Such visible particles are seen to fall back again immediately into the liquid; but it appeared to me not unlikely that other particles, too minute to be seen, might be simultaneously projected, and by reason of their masses in relation to their sectional areas, might continue suspended in the air for a long time.

It is this condition in which the sewage of Atlanta would be placed by having it poured into our rivulets.

DRAINAGE AND SEWERAGE.

Drainage and sewerage are so intimately connected that many have supposed they were convertable terms. Drainage

*Dr. Rauschenberg quotes authorities to show the inodorous character of sewage (fresh) at outfalls. When this occurs it is due to the fact that putrefactive action has not taken place as is evident in the statement above given. Sewer gases are forced into dwellings by pressure, and after more or less stagnation.

is very different from sewerage, as will be shown. Defective drainage violates the first rules of hygiene. A recent author has well remarked: "Proper drainage, and the proper disposition of the accumulated filth of a city are two of the marks of a high state of civilization, while the absence of these savors strongly of barbarism."

To correct misapprehension, it may be well to define what sanitarians understand by the terms drainage and sewerage. "There is a general impression," remarks General E. L. Viele, "that sewerage and drainage mean the same thing, or, if there is any difference, it is that sewerage is applied to cities and drainage to the country, and this erroneous idea has been the cause of a great deal of mortality in large cities—as in New York—where drainage as a distinct feature of improvement, has, until within the last few years, been entirely ignored. A drain is intended to remove from the soil the super abundant moisture that produces or influences animal and vegetable decomposition." "A sewer is to carry off surface water or liquified refuse of dwellings. From its nature, it cannot be a drain, as water cannot percolate in it; nor can a drain be converted into a sewer, as the refuse liquid would percolate into the earth, polluting wells and springs."

From this definition of drainage and sewerage, it will be seen that the so-called sewers of Atlanta, (except the earth-pipes now employed by the city engineer) are not sewers, but drains, allowing the percolation of their contents into the adjacent soil.

Dr. John Simons remarks: "As the object of a sewer's existence is to prevent stagnation of filth in, or about, houses and frequented places, and to guard against the dangerous pollution of air and soil which the filth, if not effectually conveyed away, must occasion, so, of course, any sewer which, itself, occasions any such stagnation and pollution, is (in proportion as it does so) unsuccessful; and a sewer which stinks at its open gratings, is, *pro tanto*, giving evidence of such unsuccess." The so-called sewers of Atlanta, under this ruling, must be condemned as dangerous to life, and totally unfitted for the purposes for which they were intended, *i. e.*, the conveyance of excremental filth.

REMOVAL OF REFUSE.

Removal of refuse is of the utmost importance to any city, in order that the health of its citizens may be preserved. Professor Corfield, of London, Professor of Hygiene and Health Officer, remarks: "A little reflection will show that there is one condition necessary for the conservation of a healthy state in all communities, which over-rides all other conditions and thrusts itself into an importance of the first order. It is only a matter of secondary consideration whether a town is situated on a porous, gravelly soil, or upon an impervious clay. We must first ask the question applicable to all communities—how does it get rid of its refuse matter? Indeed, a moment's consideration will show that the very fact of a town's being situated on a porous soil, of itself a condition favorable to health, may, if the refuse matters are not satisfactorily got rid of, become a reason for the pollution of its waters, and the poisoning of its inhabitants by their own refuse. The refuse of a town consists of: 1. The fouled water, which may be taken as, at least, equal to the water-supply; 2. The excretal matters, consisting of the fæces and urine of human beings and of domestic animals; 3. What is known as dust, which contains, besides ashes, a quantity of kitchen refuse of various kinds, including much vegetable, and even animal, matter, which putrefies, rendering it necessary that this kind of refuse should be removed from the vicinity of habitations as soon as possible. Almost all collections of human beings, then, agree in one point, and that is in the removal of a large portion of their refuse matter, including the greater part of the urine, along with the foul water, which is generally turned into the nearest stream, but they differ as to the mode of disposing of the remaining excretal refuse. Two things have long been recognized: 1. That these matters are valuable as manure; and 2. That they pollute the water of streams into which they are turned."

The consideration of the removal of fæcal matters will now claim our attention. The removal of liquid filth will be considered in another place.

WATER CARRIAGE SYSTEM.

This system has its advocates among the most intelligent sanitarians. It is proper to say there are cities so large and

so compactly built, so situated as to topography, formation of soil (being sandy and porous,) and having unlimited water-supplies for all purposes, and being located on some large stream or near the sea, as to make the system an indispensible necessity. This is the case with many of the cities and towns of England. The water-supplies of these cities and towns being ample, conjoined with good drainage and sewerage, their sanitary conditions have been greatly improved.

The conditions surrounding Atlanta are totally different The topography of Atlanta and the geological formation upon which it rests is extremely favorable for surface or natural drainage. The tophographical map published with the proceedings of the Commission, show the rise, course and number of the runlets flowing from the city. These runlets are so small in the volume of their waters as to be easily stepped over at almost all places. The excellent drainage is due to high elevation. One point, that portion of the city on Peachtree street, opposite the residence of Hon. John H. James, is of greater elevation than any locality within twenty miles, Stone Mountain alone excepted. Other portions attain almost as great elevations. Drainage therefore as defined by sanitary authorities is scarcely required in Atlanta. The undulating surface and the clay soil, many feet in thickness, furnishes the best possible conditions for effective surface or natural drainage. There is little need for under-ground drainage. The rain-falls are rapidly carried away, so that in a few hours no evidences are visible except the marks of cleanliness left behind. The argillaceous soil is not permeated to any great extent by surface water, which is disposed of as shown above and by evaporation. The problem then for solution by the Commission for sanitary improvement does not, to any considerable extent, include drainage, only so far as to get rid of the soiled waters of the city. It does not and cannot properly include sewerage as a means of establishing a water-closet system, for the same reasons and others to be noticed. The water-carriage system cannot in part or whole, meet the sanitary requirements of Atlanta. On the contrary, that system, if carried into *complete* execution, will inevitably prove anything else than a blessing to our people. Our city as shown, is not situated upon a plain, with a sandy and porous

soil, as is the case with the sewered cities of Europe and those generally of America. For these cities drainage is equally as important as sewerage, but they are distinct, and have far different objects in view. The lowering of the water-level and the drying of the soil by drainage, has lessened the death-rate of English cities, independent of the water-closet system, to say nothing of the new supplies of unpolluted and pure water.*

Is it the duty of the Sanitary Commission to recommend the water-closet system of removal for Atlanta?

In the discussion of the proposition, let it be admitted, for argument sake (all things being agreeable) the water-closet system is the best and most perfect yet employed for the removal of excrementitious matters. If, therefore, it be the best, under what conditions is it made so? If the system is submitted to an analysis, it will be found that it consists of five, and occasionally of six, distinct elementary parts, which will be enumerated as follows:

1st. A system of well arranged and well constructed sewers.

2d. An ample water supply to keep the sewers constantly clean.

3d. An outfall for sewage at a "considerable distance from the town."

4th. The discharge of sewage "into the sea, or into a large and rapid river" (said sewage to be thus carried) many miles below the exit of the sewers.

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* Attention is called to the following language of the Board of Health of Massachusetts: "Undoubtedly bad ventilation, bad domestic arrangements, defective plumbing, and polluted drinking water from intermittent supplies, have given rise to a considerable amount of disease, and this has generally appeared about three years after the completion of works of water supply and drainage, because it requires about that time, under bad management, for filth to accumulate and for the poison in the air and water to become sufficiently concentrated to cause illness. Hence has arisen the extraordinary statement that water supplies and complete sewerage lower death-rates for three years, and then increase them."

If under favorable conditions, this state of things occur, it would be well to inquire how long would it take to render our city permanently unhealthy, where none of the natural conditions exist to make the sewerage system successful? Commercial damage most surely follows upon the appearance of epidemic visitations in our cities. Epidemics are well said to be "Nature's protest against the violation of sanitary laws."

5th. The discharge of sewage into a *river*, which must be forty times larger in volume than that of the sewage.

6th. The necessity (as admitted on all sides, so far as Atlanta is concerned) of sewage farm-irrigation, or some precipitating process, to supplement the system, being a *forced* condition under the difficulties of the water-carriage plan of removal.

A further analysis of these conditions shows that they must be divided into two divisions:

1st. Those that are artificial.

2d. Those that are natural.

That is to say, some of these conditions are under the control of man, and hence *artificial*; and that others are not under his control, but subject to natural laws, and are therefore *natural*.

The correctness of this division will be seen by referring to the conditions. Three of these conditions are controlled by human intelligence, to-wit: the construction of sewers; the erection of water-works, and the precipitating processes or farm-sewage-irrigation.

The other three conditions are not under the control of man. He cannot create the sea, or the large, rapid river, and have the sewage poured into them at a considerable distance from the city. It is also true that the natural conditions are of equal importance to the artificial in the perfect working of the system—perhaps more so. If nature denies these conditions to our locality, no artificial means can supply the want, and our people—however much they may desire the water-closet system—must bow to the inflexible law imposed.

Are these conditions—every one of them—necessary for the successful working of the water-closet system?

The International Medical Congress, which assembled at Philadelphia 1876 (numbering among its members many of the most experienced sanitarians of Europe and America) investigated the subject, and in the Section on Hygiene the following conclusions were offered and adopted:

1. Every plan for the laying out or extension of a city or town, should have, as an indispensable part of it, a corresponding and coextensive plan for the continuance or substitution of the natural drainage of the locality, and for the proper construction of a system of sewers (for surface drainage.)

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2. The question in regard to the removal of waste and impurities from towns is not as to the maintenance of sewers (for refuse drainage), but as to whether they should be depended upon alone, or should be supplemented, more or less largely, by other means of conservancy.

3. Every sewer (for refuse matters) not supplied with a sufficient flow of water to secure the transportation of its contents is a nuisance, intensifying the evils it ought to remove. Ventilation of sewers will mitigate, but not entirely correct such evils.

4. *Conditions* SUFFICIENT FOR SANITARY SECURITY *are afforded by the discharge of sewage at a* CONSIDERABLE DISTANCE *from a town,* INTO THE SEA, OR INTO A LARGE AND RAPID RIVER, *whose water, at least for many miles below the exit of the sewers, is not used for drinking.*

All sanitarians are agreed upon these points. The Massachusetts Board of Health says:

"In Berlin, a scientific commission was appointed in 1862, and made exhaustive experiments, continued through many years. They proved by scientific analysis, and by induction, what had long before been learned in England by practical experience:

1. That with cesspools and privies, the soil and well water became dangerously polluted.

2. That sewers need not pollute the soil.

3. That streams become so foul when used as receptacles for sewage, that measures must be taken for their purification."

The Rivers Pollution Bill of 1875 (England) "provides that no liquid or solid sewage be passed into lakes, canals, streams, or rivers, *unless it be first purified by the best practicable and available means.*

Dr. John Simon, Chief Officer of the Privy Council, speaking of the supposed advantages of the water-closet system, says:

"Those advantages, however, may fail to be realized if the system be adopted without due circumspection; and the CONDITIONS which ought to be kept in view in order to avoid any such failure are apparently these three:

"1st. That the closets will *universally receive an unfailing sufficiency of water* properly supplied to them.

"2d. That the comparatively *large volume of sewage* which the system produces *can be in all respects satisfactorily disposed of;* and

3d. That on all premises which the system brings into connection with the common sewers, the construction and keeping of the closets and other drainage relations *will be subject to skilled direction and control.*"

The State Board of Health of Massachusetts, among others, makes the following recommendations:

"That no city or town shall be allowed to discharge sewage into any water-course or pond *without first purifying it,*" * * and "that any intended discharge of sewage" must "be shown to be at such a point or points that no nuisance will arise from it."

"That no sewage of any kind, whether purified or not, be allowed to enter any pond or stream used for domestic purposes."

"That steps should be taken, by special legislation, based upon investigations and recommendations of experts, to meet cases of serious annoyance arising from defective arrangements for the disposal of sewage."

Prof. Corfield, of England, remarks: "Small rivers may be, and often are, converted into open sewers, from the discharge of sewage and other refuse matter into them."

It is a sanitary law, sustained by the highest authorities, that the stream or streams into which sewage is to be discharged, must be—to be entirely safe—forty times greater in volume than the sewage. The International Congress says, as seen, that sewage must be discharged into a river, and moreover that the river must be *large;* and not only *large*, but its *current must be rapid.*

WATER SUPPLY.

From a consideration of the conditions necessary for the successful operation of the water-closet system of removal, it will be observed that Atlanta is not favorably located for water carriage. It is believed that the water supply is insufficient to serve every other purpose and to keep the sewers contstantly clean. If Atlanta should be thoroughly sewered, over one hundred miles of sewers must be constructed. Dr. Bell, one of the most accomplished sanitarians of this country, and editor of the "Sanitarian," in a letter to the writer, says:

"Knowing the amount of pipe supplying water with which your sewage starts on its course is essential to an approximate sufficiency of the body of water into which it—the sewage—empties. The smallest accepted estimate by authorities into running water is 1 to 20, *it had better be not less than* 1 *to* 40."

That is to say, the volume of the stream into which sewage must be discharged must be forty times greater than the sewage. Now, Dr. Corfield states that the liquid filth alone of a town is equal to the water supply, to say nothing of the excremental matters. It will be seen, therefore, that until it is demonstrated that the five runlets—all rising within the city limits, and flowing not more than a mile and a half from their sources (any one of which can be stepped across), and the proposed outfalls of the sewers, into which the sewage must be poured—are forty times greater in volume than the water supply, the water-closet system cannot receive the indorsement of the Sanitary Commission.

An opposite opinion is entertained, (while ignoring the volume of water contained in each rivulet) based upon the estimate that thirty-five gallons of water for each person is sufficient for all purposes, and to flush the sewers. If this were true, it does not dispose of the main question at issue, viz: The size of the rivulets. This estimate is, however, low, and is made upon the basis of an *intermittent* water service. Our system is a *constant* service, and the stream cannot afford sufficient water under this service for our population. Upon this point Professor Corfield remarks: "It is one professed object of the improvements to substitute cheap water-closets in place of common privies, and to make the system of constant supply available for the immediate removal of the refuse; nothing, however, can be more obvious than that, without the adoption of some very adequate means of prevention, the immense consumption of water in situations where waste is productive of no inconvenience to the consumer, would not only greatly exceed the capabilities of any water-works establishment, but would also ultimately, and that inevitably, occasion the entire abandonment in this (London) as in several other considerable towns, of the beneficial system of constant service."

The consumption of water is much greater in American than in European towns. The daily quantity used in New York is (according to the Sanitarian) three hundred gallons per capita.* Quite three-fourths of the water to be used in

* In the *Constitution*, of this city, the following appeared:

"The city of New York has nearly outgrown its water supply. When her great aqueduct was constructed over one-third of a century ago, it was estimated that forty gallons a day for each inhabitant would be a liberal allowance. This estimate has not been sustained by experience. The ratio has gone on increasing until it is now ninety-five gallons daily for each inhabitant. New York is, however, the best watered city in the world. Chicago's ratio is eighty gallons per head; St. Louis' ratio is sixty gallons; Philadelphia's fifty-six gallons; Cincinnati's fifty-three; Baltimore's forty; Milwaukee's twenty-five. On the other side of the ocean, Dublin's is sixty gallons: Paris thirty-eight; London sixty-three; Liverpool thirty; and Sheffield twenty gallons.

"The daily capacity of the water works of Atlanta is 2,000,000 gallons, or 57½ gallons per day to each inhabitant, counting our population at 35,000. This would not be more than we would actually need, if our people entirely relied upon the city's supply of water. As the case is, we consume 780,000 gallons a day, or about twenty-two and a third gallons.

Atlanta will be employed in sprinkling the streets, which being evaporated will not enter the sewers. As the water works are extended, this demand upon the water-supply will call for a consumption, under our service, of more than the capacity of the furnishing stream. In addition to this, a large quantity of water will be used in irrigating vegetable and flower gardens, lawns, by fountains, etc.; and the water, in many instances, will be poured upon the soil and absorbed by it.

POLLUTION OF STREAMS A NUISANCE.

On the other hand, if the water-supply was sufficient, which has been shown, on the scale contemplated, is not the case, the construction of sewers for the removal of excremental refuse would result in serious damage to the health of our people; for it is quite evident that the excreta poured into the runlets from a population of 40,000 persons would convert them into open sewers. The water in these runlets fall far short of being twenty times greater in volume than the water-supply, when forty times the volume is demanded for perfect safety, or rather a "*large rapid river.*"

The advocates of water-closets for Atlanta seem to give but little thought to the possibilities of its future growth. As the city enlarges the water-pipes and sewers will be extended. The population may increase so largely as to require additional water-works. Miles of sewers will become necessary, if necessary at all. Manufacturing establishments in the near future will spring up, increasing the amount of liquid refuse

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for each inhabitant. We have nothing to fear from that source, therefore, for at least several years to come, although our present ratio of consumption exceeds that of Manchester and several other large European cities. We are, in fact, very liberal consumers of water, when the limited territory covered by the water pipes is considered; and perhaps in the future the subject of water wastage will become a practical question with us."

Chicago has an immense water-supply. Boston obtains its water-supply from two sources—one at Brookline, with a capacity of 120,000,000 gallons; the other at Brighton, five times as large—at a cost of $20,000,000. Philadelphia gets a daily water-supply of 150,000,000 gallons. The reservoir at Richmond has a capacity of 40,000,000 gallons.

It will be observed that the consumption of water already in Atlanta, is excessive, especially in view of the fact that no system of sewers, and but few water-closets, exist to be kept clean, which would require a much larger quantity.

added to that of the increased solid refuse. A large portion of the surface refuse, as well as that from manufacturing establishments must, in the nature of things, be carried into the runlets. Thus, while these runlets will remain as small as ever, the surface washings and other refuse will annually increase in quantity. If the sewerage system shall, *pari passu*, increase with the growth of the city, having, say 100,000 inhabitants, what will be the condition of these runlets into which all the filth from all these sewers shall be poured?

To show the prospective condition of these runlets under these circumstances attention is called to the poisoning of water and water courses by sewage. When water is contaminated with sewage, it is difficult of purification. An eminent English authority asserts "that streams become purified by a flow of twelve miles, if not more than one-twentieth part of their volume has been made to consist of sewage." Dr. Frankland states that no river in the "United Kingdom is long enough to purify itself of sewage." The Massachusetts Board of Health says:

"Much has been said as to the complete self-purification of rivers (the rivulets of Atlanta would be far more difficult of self-purification) by a flow of a few dozen miles. *No such power exists.* The solid parts are deposited, and what remains looks clear and bright, especially when largely diluted. Chemical changes take place too—sometimes decomposition, sometimes putrefaction, sometimes simple elective combinations. If sewage contains the "germs" of disease, whatever they may be, no agency at present known, except a sufficiently high temperature, will effectually destroy them." The Rivers Pollution Commission of 1875, says: "*Slow* soakage through a few feet of gravel destroys more organic matter than does a flow of many miles in the Thames."

In 1860, the Sewage Town's Commission in the second report says:

"That the pollution of the streams had become an evil of national urgency, requiring the earliest and most serious attention, with a view to the application of remedial measures.' It further says: "The (rivers) Irwell, the Irk and the Medlock, at Manchester, have long been notorious for offensiveness, both to sense of sight and smell. * * The bright stream above Middleton, is made black and repulsive, immediately below the town. * * The bright water of the Bradshaw brook and reservoir soon become the color of ink. * * The discharge from some of the large towns (on the rock) must, in summer time, become a very dangerous nuisance. * * The water of the Mersey has become a black offensive liquid. * * At the time of our visit a black, thick, noisome scum covered the surface of the river and canal, and bubbles of gas constantly burst

up from below, although the weather was very cold. In summer this scum on the surface is said to be much extended, and at times of such consistency that birds walk over it. The stench is described as scarcely endurable."

It is also stated: "Down to the year 1874, the sewage of the English town of Coventry--population 40,000 --was cast into the river Sherbourne in an undefecated state. It rendered the stream black and disgusting, and a terrible nuisance to the neighborhood as well as a great danger of health."

The editor of the London "Lancet," of the year 1876, remarks:

"The condition of our rivers (*not rivulets?*) and streams, so rapidly passing from bad to worse, has long been recognized. * * * We have before us as we write, the 15 folios in which the results of these elaborate inquiries (by the Rivers Pollution Commission) are presented. * * * The two final reports contain the mature recomendations of the Commission founded on the results of ten years of patient study."

An American sanitarian, Dr. Hays, of Philadelphia, commenting on the above, remarks:

"The subject of rivers pollution is exciting great attention in Great Britain, and is one of great importance in this country, where we are premitting this nuisance to be established, and which if not timely arrested will be sustained by so many pecuniary interests, that however prejudicial to health, it will be difficult to abate as is found to be the case in Great Britain."

In England, Dr. Corfield says, by the common law, "it is a nuisance to pollute the air we breathe, or the water which flows in any stream, for we have a public right to the first being kept in a state of purity, and to the latter when flowing into private land the riparian owner has a right that it shall be kept free from admixture of noxious matter, and the public have a right in all flowing water that it be kept pure; and it is a nuisance for any one to do any act which lessens the enjoyment of any matter or thing in which there can be any property." "And it is by the authority of the common law that injunctions have been obtained against local sanitary authorities in various parts of the country, restraining them from pouring into rivers the sullage of the towns and cities over whose health they are the appointed guardians. These bodies, in attempting to remove the nuisance at their own door, have committed the most wide-spread injury, polluting one of the main requisites of health and bringing discredit on all sanitary operations." "Sanitary authorities being armed with great powers to prevent injury to health are not permitted themselves to do anything which would amount to a nuisance, or cause the sewage to flow into any stream or river, if injury to health is likely to arise."

Also, he remarks: "There are two kinds of evils that arise from fouling rivers, two especially, but there are plenty of others in addition. The first is, that these rivers, even when they are large ones, get, to a certain extent, blocked up by the sediment that is deposited from the sewers;

this is the case, even, with the Thames. In the year 1867, it was pointed out that there was going on a formation of extensive shoals in the river Thames. These deposits were very extensive. Near the southern outfalls, for instance, a depth of fully seven feet of deposit was found, and, in fact, it was going on to such an extent that it threatened to interfere seriously with the navigation. Now, in small rivers, this is, of course, a very serious matter." "The danger, of course, increases the smaller the bulk of the river is in comparison with that of the sewage. Small rivers may be, and often are, converted into open sewers, from the discharge of sewage and other refuse matters into them." Again he remarks: "Where sewage is turned into the sea (provided the outfall is at sufficient distance from the town, and that currents do not set toward the latter) no nuisance is likely to be experienced, but when, as in many cases the sewage is discharged close to the town or over the beach in front of houses, the nuisance becomes considerable and the damage great. Where, on the other hand, sewage is discharged into rivers, even with due provision to prevent backing up in the mains, banks of sewage form, blocking up the channels, which, when left high and dry, give out pestilent emanations."

The editor of the London "Lancet," 1876, referring to a large meeting upon the pollution of streams, says: "An influential meeting was held, the Duke of Buccleuch in the chair, to consider a report read by Mr. MacIntosh, on the pollution of the Scotch rivers. Sir Robert Christison, in moving the adoption of the report, said that his connection with movements of a similar kind dated from 1830; he thought that with regard to the three great necessaries of life, food, drink and air, no one ought to be entitled to pollute any of these. It was evident, moreover, from the recent action of government in sending out commissions, that, sooner or later an end would be put to the systemic pollution of our rivers."

In the report of the Board of Health, of Boston, 1874, the following statement is made: "Four sewers pour their horrible filth into the old Roxbury canal, at Albany street, and wait for the tide to take what it is willing to carry away." "The contents of these sewers are too vile and loathsome to look upon, and their odors must nauseate and poison thousands every year. This whole system of sewerage is clearly wrong. Our beautiful city is almost encircled by the mouths of sewers discharging their contents into shoal water, or upon flats, the sewer gases rendering the atmosphere, for some distance about the wharves, absolutely dangerous to breathe."

In the report of 1875 the Board says:

One of the most important things to be attended to in the construction of sewers, is to so arrange them that they shall not, under any circumstances, discharge their contents in the immediate vicinity of dwellings, nor on marshes where, until covered by a returning tide, the decomposing deposits shall lie, exposed to the action of the sun's rays, and thus disseminate their foul odors over which ever portion of the city the prevailing wind may happen, for the time being, to favor.

"At Rio Janeiro," remarks Mr. Adam Scott, "the sewage in former times was emptied into the sea, and seventy years ago that place was used as a sanatorium for the United States, but in consequence of this practice fever became so prevalent that ships refused to touch there if they could help it, and ten or twelve years ago the Rio Janeiro Improvement Company effected a deodorizing of all the houses, at a cost of £6 10s per annum for each house. This reduced the yellow fever, and since then they had adopted water-carriage sewers, but unfortunately these emptied into the harbor, and the result was something exceedingly disgusting, and the effect on health very bad. In Naples the sewage was discharged some distance from the town, and the same result took place. There was a beautiful extent of sea-shore, which had become quite a scene of death; no one could reside there, and many noble villas were falling into utter ruin. Again, at Marseilles, for hundreds of years they had discharged the sewage into the sea, and the epidemics there were well known; in fact, it had passed into a proverb in France that pilots could go into the harbor in the thickest fog, being guided by the smell alone."

DANGER TO LIFE FROM POLLUTION OF STREAMS.

The danger to life where sewage is allowed to be discharged into small streams or other localities where it cannot be speedily removed, is acknowledged by all sanitary authorities. It may not be amiss to give a few instances of visitations of epidemic diseases, brought into existence or given fearful intensity by exposure of persons and communities to sewage being deposited at outfalls of sewers. Epidemic cholera occurred at Southampton, England, under the following circumstances:

"Just before the outbreak, the pumping of sewage had been discontinued while the sewers were being cleansed. The pumping was resumed just before the outbreak, and several tons of offensive fluid were daily poured down an open conduit into the outlet sewer. The odor was overpowering, and several cases of diarrhœa and cholera occurred near the pumping station, for which no other cause could be discovered than the effluvia from the sewage. The conduit was covered, and in six days the worst was over. Dr. Parkes expressed his belief that the outbreak was mainly caused by the fœcal effluvia."

Dr. Erskine, in his report of the cholera epidemic of 1873, at Nashville, says:

"Nashville, a beautiful and attractive city, is possessed of filthy and repulsive suburbs. The small streets and lanes that surround the base of Capital Hill are occupied exclusively by the lower classes. * * * Gutters and sewers upon either side empty into the branches, which afford the only efficient drainage of the city." Dr. Bowling, in an account of this epidemic, writes: "Nashville has the best natural drainage of any town on the continent. Every drop of water that falls upon College Hill finds its way either to Brown's creek on the south or to Wilson's spring

branch on the north, etc." The Board of Health, in commenting on this, says: "This description is most admirable. * * * The drainage is simply into the valley of each natural drain. The necessities of man have obstructed this natural drainage; the streams are no longer solid currents to the river, and man has not rendered an equivalent for what he has destroyed." Dr. Bowling, referring to this drainage, remarks: "On each side of the creek, and between the fills (each serving as a dam to keep back from the river the accumulating filth above), exists a common deposit of every imaginable abomination, which lies rotting, seething, and weltering in the unobstructed summer's sun." Amidst all this the cholera reveled as never before in Nashville.

A word of comment may be necessary here. Let the comparison be made between Nashville and Atlanta. The natural drainage of Atlanta is not inferior to that of Nashville, but added to the natural drainage the latter city has a river at its side. Nashville is a sewered city. The sewers discharge their contents, with the surface accumulations, into the creek and branches, and stagnation occurs before the sewage can reach the river—hence, the unhealthfulness of that city, and its proneness to devastating epidemics. Atlanta is not as favorably situated for sewerage. The five runlets, all of which have their sources within the city limits, are many miles remote from any large stream. If Nashville suffers from epidemic diseases by reason of the pouring of its sewage into branches, with an abundant water-supply and a large river at its feet, what is to exempt Atlanta from their ravages, pouring its sewage into small rivulets, but having neither the water-supply or the close lying river?

In Augusta, of our own State, a fearful epidemic of yellow fever occurred during the summer of 1839, the spread and malignancy of which was due, upon the authority of Prof. Ford, to accumulation of filth deposited in the Savannah river near the city.

The instance of Gastonbery, England, may be given: This town has a reasonable water-supply, the sewage was discharged into an immense cesspool about half a mile from the town from which the foul emanations were blown back upon the people by the prevailing winds. The population was 3,500. Typhoid and scarlet fevers prevailed fearfully—kept up if not originated by this cause.

The recent appalling epidemic of yellow fever in Savannah

furnishes additional evidence of the danger to life caused by emanation from sewage.

The following appeared in the "Constitution," of this city:

"Savannah is located favorably for drainage and sewerage. It has an inexaustible water-supply and while on a tidal stream is sufficiently near the sea to effectually dispose of its sewage. One hundred thousand dollars has probably been expended in the construction of her sewers. The outlet of her sewers is just beyond the city limits at the margin of an old rice plantation. The old rice field susceptible of tidal overflow, skirts the eastern portion of the city. From the outlet to the river, a distance of half a mile, a canal is made an open sewer to convey the sewage to the stream. At the terminus of the canal a trap or gate has been placed, which, upon the rising of the tide closes, preventing the overflow of the old rice plantation. It has been found that sewage discharged into a tidal river is carried up as well as down, and deposited in such quantities as to seriously interfere with navigation, as well as the health of a city so located. This was the case at London until the metropolitan sytem was adopted, at a cost of $20,000,000, by which the sewage is conveyed fourteen miles below and discharged into the Thames upon a falling tide. In order to avoid one evil, and to save money, the sanitary authorities of Savannah have adopted a greater. Indeed the perfection of the sewerage system of that city will involve a larger expenditure of money than the building of the sewers. Thus it is plainly seen that our beautiful seaport has, under unwise sanitary management, become the victim of the most destructive epidemic known in its history. The old rice field lies broadside to the city. When the tide rises the trap causes an overflow of sewage and its deposition, which is left by the receding tide upon the opening of the river trap. In this portion of the city the fever commenced with deadly energy, and thence spread over the wealthier portions. The condition of our sister city was as that of a magazine of gunpowder awaiting the spark."

During the yellow fever epidemic the "Savannah News" published the following:

"The opinion of such a medical expert as Dr. O. A White upon any subject connected with hygiene should carry weight and be authoritative. We accordingly called upon the Doctor yesterday, who kindly gave us a half hour of his valuable time.

The Doctor, alluding to the sanitary condition of Savannah, said that he found the city proper remarkably clean, nothing apparently presenting itself to account for the toxic poison by which the city was enveloped. That the source of this poison was not found in the Springfield plantation, on the western part of the city, but that from an examination of Bilbo's canal, (canal referred to above) he was satisfied that that was the reservoir of the poison which had devasted our city. It was in a very foul condition—the numerous bars formed by the action of the tide and water created so many reservoirs as it were for the poison; the extreme hot weather experienced in July and August had acted as a generator; and the east winds had scattered the poison to every part of the city.

Dr. White has given to the Mayor the result of his observations as to the condition of Bilbo's canal as the poison reservoir, and it is to be hoped that, guided by the dreadful experience of the present, those who may live to see the end of the scourge will take efficient measures to insure a prevention of the return of the scourge. Surely hundreds of thousands of dollars would be well spent if the spending would prevent a recurrence of such scenes, such distress and such total annihilation of all the material interests of Savannah as we are now passing through."

Thus the question of health lies at the basis of commercial prosperity. Without this basis no city can prosper. Will it pay, commercially, to convert our salubrious city—so noted now in this particular—into one which shall become equally noted for its insalubrity and unhealthfulness?

The losses sustained by a city from epidemics may be illustrated by the late yellow fever epidemic at Savannah. In the Second Annual Report of the Georgia State Board of Health, Dr. Ely McClellan places the estimated loss to that city from all causes, at $5,862,357.

PROPOSITIONS ESTABLISHED.

It may therefore be assumed that the following propositions have been established.

1. That for sanitary purposes, the water-supply of Atlanta is inadequate.

2. If the water-supply was sufficient, there are no natural receptacles of deposit into which this refuse should be received and safely conveyed away.

3. That the rivulets into which the large quantity of refuse matters would be discharged would become polluted to such an extent as to be converted into open sewers.

That the second and third propositions are correct is conceded by every member of the Commission. Therefore, in the judgment of the Commission, (including the City Engineer) the pollution of these rivulets would, under the water-carriage system, be so great as to demand some means of purifying them, after the sewage had reach the outfalls of the various sewers.

CORROBORATING TESTIMONY.

The writer, in this connection, takes great pleasure in giving the opinions of gentlemen of many of our American cities—who have made sanitary science a study—upon the above propositions as applied to the city of Atlanta.

Dr. W. D. Bliss, of Washington city, writing under direction of the Board of Health, says: "I believe the water-carriage system to be, as a rule, pernicious and productive of typhoid and scarlet fevers, diphtheria and other prominent zymotic diseases." "The application of the water-carriage system to the sanitary interests of Atlanta, based upon your statement of its geographical position, topography and water-supply, compels me to state that, in my opinion, it would be quite impossible to construct an efficient system of underground sewerage, the debouch, or outfall of which is necessarily in small streams, or rivulets, adjacent to your city."

The Health Officer of Detroit, Michigan, remarks: "Owing to scarcity of water-supply, and smallness of streams to carry off sewage, Atlanta is not favorably located for underground sewerage, but must depend principally upon a good system of surface drainage, and that night-soil must be removed by some air-tight process, like the Odorless Evac. Apparatus."

The President of the Board of Health of Boston, (indorsed by the entire Board, as well as by that eminent sanitarian, Dr. W. L. Richardson,) writes: "1. The water-carriage system in your city would be entirely wrong; 2. The removal of excreta, under the process of Bradley, of Philadelphia, would give much better sanitary results."

Dr. H. Jones, Secretary of the Board of Health of Memphis, Tenn., says: "I do not think your city adapted to the water-carriage system. The small streams would soon be polluted, and might become fruitful sources of disease."

Dr. J. G. Cabell, Presidenl Board of Health, Richmond, Virginia, "Thinks sewers, for the purpose of conveying away night-soil, would not be desirable for Atlanta, and the smallness of the streams into which the impurities would be emptied, present insuperable objections to the contents of closets being allowed to flow into them."

The Health Officer, Newark, N. J., writes: "We should judge Atlanta is not adapted to a regular system of sewerage, but that a system of cess-pools, under proper regulations, would involve far less expenditure, and be better in a sanitary point of view."

SYLLOGISTIC ARGUMENT AGAINST WATER-CLOSETS FOR ATLANTA.

Having given the foregoing facts and extracts, a syllogistic argument will be given—and one most inexorable in its logical exactions.

Proposition: Is the water-closet system adapted to the sanitary security of Atlanta? Is it practicable? Is it possible of success in a sanitary point of view?

The water-closet system of removal, for its perfect success requires—as already shown—five distinct elementary conditions, not one of which must be absent. To enumerate:

1st. The system must have:

a. Well constructed sewers.

b. Ample water supply.

c. The discharge of sewage "at a considerable distance from a town," where it can be properly disposed of.

d. The discharge of sewage must "be into the *sea;* or into a *large, rapid* river."

e. The discharge of sewage must be into a stream or streams of forty times greater volume than the sewage or water supply.

2d. It is evident:

a. The sewers are wanting.

b. The water supply is wanting.

c. The sewage cannot be discharged "*at a considerable distance from the city,*" where it can be properly disposed of.

d. The sewage cannot be discharged into the sea or a large, rapid river.

e. The runlets into which the sewage must be discharged are not, combined, of forty times greater volume than the sewage or the water supply. And,

3d. Since a whole must consist of all its parts, and as the proposed water-closet system of Atlanta is wanting in all the conditions;

Therefore the system is not adapted to the sanitary security of our city; is not practicable; and is impossible of success in a sanitary point of view.

Now, it is possible, at great expense, to construct sewers; to procure an ample water supply from other sources than the one now being used; yet other conditions (not to include sewage farm-irrigation, which will be shown to be impracticable) are forever impossible to be obtained. *We can never discharge the sewage of Atlanta at a considerable distance from the city into the sea or a large, rapid river, nor into a stream or streams of forty times the volume of the sewage or the water supply.* It will be seen that THE ABSENCE OF ANY ONE of these conditions is fatal to the proposed water-closet system:

If Atlanta is minus the sewers, it is impossible;

If Atlanta is minus the water supply, it is impossible.

And so with all the others. *Atlanta must have the whole, consisting of all its parts, to make the system possible of sanitary success.*

SANITARY OBJECTIONS TO SEWERS.

That water-carriage, as a sanitary measure, is not the best system for Atlanta has been, by the foregoing remarks, demon-

strated. The objections to water-carriage removal are many and serious; and many sanitarians object to the system even when all the conditions for its successful working are favorable.

Water-closets, as a part of the system, are objected to by many. They have been abandoned in many English towns. Dr. Buchanan says:

"I can testify that in St. Giles's (London) parish, at the time I was myself striving to remove its nuisances, not one of the water-closets of tenemented and common lodging houses was in a state fit to be used by my first-class of objectors (to earth-closets) and probably there were not 10 per cent. of such closets which were not several times a year positive and dangerous nuisances, their structural parts broken or rotting, or their supply of water absent or their pans filled with filth through the outlets being choked."

He calls the water-closet a "delicate machine," requiring careful handling.

In speaking of the earth-system he says:

"Indeed, it turns out at last that those who admit the excellence of the earth system in principle, but denying its applicability to towns generally, have in their minds the notion, that as a town must needs have sewers for other porposes than excrement removal, the sewers may as well carry off excrement also, and that at all events change involves expense. How far this may be depends, of course, on the degree to which the place can satisfactorily (in the largest meaning of the word) dispose of its excrement in a liquid form, and whether it can do so more economically and more safely than by disposing of a solid. *Evidently many large towns*—INCLUDING MANY THAT ARE SEWERED—*are not yet assured that water-carriage is the best way of removing their excrement.*" He further remarks: "It is impossible to ignore the fact that many large English towns do not regard the water-closet system as suitable to all their particular wants, nor irrigation as being a remedy certainly suitable to their particular sewerage difficulties. I refer, of course, to towns which ALTHOUGH POSSESSED OF A SYSTEM OF SEWERS, nevertheless retain their excrement in middens or cesspools, *deliberately avoiding water-closets as not affording them the certainty of advantage which they need to have before they enter upon expensive new constructions.*"

Water-closets are here declared to be expensive—expensive in contrast to other systems—so expensive as to be "deliberately avoided." The Massachusetts Board of Health says:

"That water-closets," etc., are "*too costly to admit of universal application.*" "The water-closet is used by thousands who know little or nothing of its mechanism and who necessarily consider it as an automatic arrangement, needing little or no attention, and who therefore bestow none upon it. But, as it is no more perfect in its way than all other works of human hands, it has many faults and weak points."

Dr. John Simon says: "It has always to be remembered that the working of an ordinary water-closet is easily deranged, and that water-closets when out of order, and especially if in the interior of houses are apt to become very dangerous nuisances. The ordinary water-closets *is therefore a thoroughly ineligible form of privy* for those who are unlikely to take proper care of it, or are from poverty unable to give it such occasional repairs as it may require."

He also remarks: "It cannot be denied that ill-advised and ill-managed water-closets and their accompaniments have caused (and particularly among the better-off classes of society) *filth-diseases to a very large extent.*"

In these remarks the poor and rich are said to be sharers in the evils flowing from the water-closet system.

As a concomitant part of the water-closet are the waste-pipes, etc., in houses. The Massachusetts Board of Health says:

"The demand for modern conveniences has introduced waste-pipes all over our houses. Their orifices are found in the bed rooms and on every floor, from attic to cellar. With perfection in planning, workmanship, and management, such things may possibly be made safe. But we cannot expect perfection in either of these departments. The nearest approach to it ought to be looked for among the houses of the wealthy whose means can command the services of good architects and good workmen, and who are not stinted as to the cost of such appliances as conduce to safety in drainage. But it is precisely in the most costly houses that the water-pipes are found most widely scattered. The chances of imperfect work are too great to justify the practice of putting wash-basins or water-closets in sleeping rooms, under any circumstances, or even in dressing-rooms, closets or passages leading directly from sleeping-rooms, unless these conveniences are supplied with the most ample and thorough ventilation, put together in the most careful manner and most scrupulously taken care of. English authorities say that water-closets should be built over one another in a tower projecting from the house."

The Board of Health of Cincinnati, 1873, reports as follows:

"The sanitary advantage of properly sewering (draining) a city, in order to carry off the surface drainage, cannot be over-estimated. At the same time the system of sewerage adopted in this city and elsewhere is open to criticism, and is apt to give rise to annoyance in the future. The injurious effects arising from sewers for the purpose of draining off night-soil, deserves more than a passing notice. The connection pipes leading from private residences to sewers, are often imperfectly constructed, and the result is that the sewer gases enter the houses of our citizens, much to the detriment of their health." * * * "It can be safely asserted that, if our citizens are to be obliged to tap the sewers for the purpose of night-soil drainage, a greatly increased mortality from zymotic diseases will re-

sult therefrom. It would highly become your honorable body (the City Council) to inquire into our public sewers. By so doing, violent epidemics of zymotic diseases must be prevented."

It will be remembered that Cincinnati is located on the banks of a large navigable river, has magnificent water-works, and that the natural drainage is excellent. Under these circumstances it would seem to be most favorably located for the water-closet system, and yet the Board of Health, headed by that distinguished physician, Dr. Thomas M. Minor, objects to the employment of sewers, for night-soil drainage, upon sanitary grounds alone.

Dr. C. C. Cox, President Board of Health of the District of Columbia, in his report of 1874, writes:

The removal of human excreta, has been one of the vexed problems of centuries. Shall it be carried away through sewers? Is it practicable perfectly to avoid the reflux of sewer gases into human dwellings, by the best known construction of those conduits? And, if practicable, is it not of paramount consideration to utilize the excremental material in such manner as to improve agriculture, and thus contribute to the substantial wealth of the nation?

These questions have been exhaustively discussed. In some cities of Europe only the surface drainage, waste-water and slops, are allowed to enter public sewers. While trusting that such a reform may soon become universal, we must treat the whole subject from the existing stand-point. Hopeful as we may be of the period, in the near future, when not a drop of urine or particle of excremental matter shall enter the common sewer, but when all the excreta shall be utilized, we are convinced that epoch has not been reached. We must see, now, that this necessary evil be placed under the best possible condition for the conservation of health. Until water closets shall be abolished, as they must be in the progress of time, we must endeavor to render them, as far as possible, void of offense and detriment.

Another sanitary authority says: "The legitimate use of public sewers is to conduct the surface drainage, and it is becoming a well settled conviction in the minds of sanitarians that nothing else should be allowed to enter or pass through them. Experience has demonstrated the impossibility of constructing traps capable of preventing, under certain circumstances, the driving of sewer gases through the drains and pipes into houses and chambers. To remedy this and the horrible stenches that continually creep through the sewer-eyes and man-holes, along the line of streets and alleys, air shafts and gas consuming chimneys have been constructed, but, it is believed, without satisfactory results."

Dr. Lecardre, Vice-President of the Council of Public Hygiene and Salubrity of the Arrondissement of Havre, says:

Rivers and canals existing in great cities ought not, under any cir-

cumstances, to serve as drains for sewage; they ought solely to be taken advantage of in this respect as affording facilities for transporting it to districts where it may be used for fertilizing purposes. The state of the Thames, poisoned by the sewage of London, should not be forgotten. It is contrary to all the laws of health to suffer a river or canal to become polluted, and to all the laws of good economy to lose, thus gratuitously, a product so rich and precious. The tubular system of sewerage, although it has been applied to several parts of England, has not yet been sufficiently studied, and it is so expensive that few cities in France could support the cost.

SEWER GASES.

The danger of sewer gases upon the health of a population where the water-closet system is adopted is well known and well established. It will therefore be only necessary to call attention to the fact, and give a few instances as illustrative of the danger of these gases to life.

Prof. H. R. Noel, M.D., of Baltimore, in a paper read before the Public Health Association, says.

The action of sewer gas upon the constitution is difficult of solution. The malignant influence stamps its mark upon all classes. In one family, consisting of eleven members, a disease of an endemic character broke out, and three of them had scarlet fever and five diphtheria. * * * In some of the patients the two diseases were blended. In another family a mother and daughter were stricken down with typho-malarial fever. In each of these the cause was the same"—sewer gas. "Our ordinary vital statistics give only deaths. No mention is made of confirmed invalids and of those who suffer from the effects of causes of this kind.

Other instances could be given, but it is not deemed necessary. It is here proper to add that, as Dr. Corfield remarks:

"It is perfectly certain that a certain amount of sewer air, as it is called, is contained in all sewers, and is given out from sewers, and is given out from sewage, *whether there is much stagnation or not.*"

From this it will be seen that the most perfectly constructed sewers are not free from sewer gas. Should sewers be constructed in Atlanta, cesspools of greater or smaller extent will be formed at their outlets. These outlets being, say one hundred feet below the water-closets, the sewers will act as chimneys for the gases, which will ascend them by being lighter than the atmosphere. By this means houses having water-closet connections will be liable to be poisoned by sewer gas. This will be the case particularly during periods of hot, dry weather in mid-summer - the very season when fevers most prevail in our climate..

The town of Croydon has been referred to as a noteworthy illustration of the benefits of the water-closet system. The "British Medical Journal," May 20, 1876, gives the following:

THE EPIDEMIC OF TYPHOID AT CROYDON, ENGLAND.—Dr. Buchanan's report on the late epidemic at Croydon, appears almost simultaneously with the subsidence of the disease; having been at first epidemic, then endemic, typhoid fever has at last disappeared, after fifteen months sojourn in the district. There have been in all about 1,200 cases of fever in 942 houses. The disease was due to "the escape of infected air from the sewers, and its inhalation by persons susceptible to the disease."

He makes, among others, the following recommendations:

The direct communication of houses with sewers must be interrupted, and an efficient independent system of ventilation applied to every house drain.

Means of flushing must be provided, such as shall not endanger water services.

There must be a separation of all water pipes from immediate connection with sewers.

From the above recommendations, the water-closet, while a "delicate machine," and costly (too costly for universal use) as well as "delicate," gives to sewers the materials from which are generated the poisonous gases. Houses using water from water-works must necessarily connect, by pipes, with the sewers, and thus an avenue is opened by which sewer gases may not only enter the houses, but poison the water used.*

As stated, our water service is "constant." Now, Dr. Simon on this subject remarks:

"Again, a different sort of danger, and one which seems capable of wide operation, has been seen to arise where water-closets receive their flushing service from the mains of a so-called "constant" supply; for supplies called constant must not only sometimes intermit for purposes of necessary repair, but also in some cases are habitually cut off during the hours of night; and the danger is that, during times of intermission, if

*The City Engineer, in his annual report decides that sewer gas, under good sanitary engineering, cannot escape into houses. He also remarks: "In a former report the immediate decrease of the death-rate has been mathematically shown after the introduction of sewers in Croydon, England, as an example." Now, he should have added that the sewerage of that city superseded the "Midden" system—a system allowing unlimited poisoning of the water. Also that this improvement in the health of Croydon was due as largely to the water-works which were erected at the same time. In Dr. Buchanan's report, it is medically, if not "mathematically," demonstrated that the death-rate for 1875 of that city, from sewer gas contamination, was nothing of which to boast.

there be no service-boxes or cisterns between the privy taps and the mains, privy effluvia, and even in some cases fluid filth, will be (so to speak) sucked from closets-pans into water-pipes. This danger, which hitherto has been little known to the public, but which it is important to have well understood, is illustrated by two remarkable reports, respectively by Dr. Bloxall and Dr. Buchanan, on outbreaks of enteric (typhoid) fever thus occasioned." "Dr. Buchanan's report illustrates the filth-causation of enteric fever clandestinely effected under circumstances where, *prima facie*, any filth disease would have seemed impossible."

COMPLAINTS OF OPEN SEWER NUISANCE.

Atlanta is not, to any great extent, a sewered, or a water-closet town, and the rivulets within its limits are already poisoned by the sewage poured into them from the water-closets in the central portion of the city. The so-called sewers (drains) pour out their impurities within a short distance of many of the dwellings of our people. By this means, these rivulets are already converted into open sewers. It is but a small matter at present, and yet the mutterings of discontent are annually on the increase. It is but the first prattle of rain-drops before the storm. It will be well to remember the history of the Thames (a large, navigable river) being converted into an open sewer, under similar circumstances. It offers Atlanta an illustration and a lesson. Under the system of discharging the sewage immediately in the Thames, that river, says a recent writer, "was rapidly becoming a gigantic sewer, and three warnings, in the shape of cholera epidemics, 1832, 1849 and 1854, combined with the powerful incentive to action in the matter produced by the effluvium of the Thames upon the legislators in the House of Parliament led to the inauguration of the metropolitan main drainage system, in 1859." After a labor of sixteen years, and an expenditure of $20,000,000, this undertaking has been accomplished, and the sewage of London is discharged fourteen miles below into the river at high-water, in order that the tide may carry it out to sea." Atlanta has no sea, or river, available for a similar purpose.

Those of our fellow-citizens residing on the rivulet into which the water-closets of the Opera House, the National Hotel, the Kimball House, and other public institutions empty, (Loyd street sewer) complain bitterly of the nuisance, and insist (and correctly so, if the nuisance is not abated) that

this rivulet shall be sewered beyond the city limits. Cases of typhoid fever resulting in death, have occurred as a result of the unsewered portion of this rivulet. Property has depreciated in value fifty per cent. it is said, and homes have been abandoned in consequence of the fearful character of the nuisance.*

Should Atlanta be completely sewered, and its immense amount of sewage discharged into the rivulets, just beyond the city limits, what would be the consequences? The discharged sewage would be constituted into open, elongated cess-pools, annually increasing by being incorporated with the mud and vegetation along their sides, for miles—a seething mass of corruption. These rivulets, flowing from the city at all the cardinal points of the compass, thus converted into open sewers, would poison the atmosphere of the city at all times and all seasons. No wind, from whatever quarter it

* Since this report was written, the Committee on Sewers and Drains, of the General Council of 1876, in its annual report, makes the following statement: "The sewer on Loyd street is the main sewer of Atlanta. It drains nearly one-half (?) of the city. The amount that passes through it is enough to poison the whole southern portion of the city, and cause its entire depopulation, unless the pipe is extended to the city limits. The committee urgently recommend the incoming council to extend and complete the sewer." The extension called for is necessary: 1. Because, under any system, the liquid filth—as shown further on in this report—will require this "pipe extension;" and 2 Because, if the water-closet system is not entirely abolished, the ravine referred to will become an open sewer in a populous portion of the city, and result in a fearful nuisance. It requires no argument to show that if, at this time, when only a fraction of this refuse is poured into this rivulet, it is enough "to poison the whole southern portion of the city, and cause its entire depopulation," that, even should "the pipe" be extended to the city limits, the nuisance, and danger to life, will still exist and be in full operation, aggravated by the increased amount of filth which will inevitably be discharged at its outlet. If the committee, in the one case, be justified in using strong language, the latter condition of things will surely call for stronger language still. A "pipe extension," or any other "sewer extension," if allowed to carry excretal matters, will pour out filth "enough to poison the whole" portion of the city near such outlets and cause their "entire depopulation" in process of time. Extensions *now*, signify simply a change of the place of deposit, without the possibility of escaping the pollution of the rivulets, or of abating the nuisance at the termini of the sewers. In fact, the nuisance will be intensified *pari passu*, with the increase in the accumulation of filth at the outlets.

should blow, but would, along with it be borne these pestilent emanations.

The poor living on these rivulets and the people just within the city limits would suffer most, and epidemics from this cause, no less than from the poisoned air in the center of the city, would, under such circumstances, find numerous foci from which to spread. These rivulets so polluted would become nuisances of such magnitude as to compel property holders residing near them to appeal to the law for their abatement. And in the end our city would suffer loss by expensive litigations. A distinguished English writer, editor of the "British Medical Gazette," sums up the argument by putting the question, which, under a system of water-carriage would be as applicable to Atlanta, thus:

"Whether the present system of removing excremental matters from our houses by the agency of water has not created more waste, and greater sanitary danger, and more expensive litigation than any other system which the ingenuity of man could have devised? Not forgetting that the water which is thus wastefully and irreparably fouled, amounts to from 20 to 30 gallons per head, of the population daily, and has been brought at great cost from the purest sources, and perhaps filtered in the most careful manner. What other nation would have been guilty of such folly?"

A question as pertinent to Atlanta as it is to the people of English towns.

COST OF SEWERS.

The Commission has received no positive data as to the cost of sewering the city. Earthen pipes are recommended by the City Engineer. Some Engineers in this country advocate the employment of these pipes for sewers, upon the ground that they rid themselves of their contents better, and with a smaller quantity of water than large sewers. There can be no sanitary objection urged against these pipes when over six inches in diameter. The City Engineer proposes to use two feet pipe for mains. All house connections and laterals must be smaller. Dr. Buchanan in a recent report, gives some strong reasons against the use of small pipes. He says:

"If a six-inch sewer be not running well and a pail of water be thrown into it, the water will occupy sixteen times the space relatively to the sewer diameter that it would occupy in a two-foot sewer; the displacement of air in the smaller sewers will be relatively sixteen times as great, and will be greatly more sudden. Hence the air in a small sewer will be under far greater pressure than the air of a large sewer."

It is usually by pressure in sewers that sewer gas is forced into houses. With an increase of pressure the danger of escape of sewer gas into houses also increases, a fact made evident by the epidemic of typhoid fever at Croydon, under such circumstances.

Small 12 to 25 inch pipes for mains, the City Engineer estimates, will cost $8,000 per mile. Should the city be completely sewered at half this estimate, it would require the expenditure of $540,000.* Dr. Rauschenberg estimates the cost at $190,000. This much can be said: any system of sewerage is expensive. More than this, when constructed, there must be constant repairs going on. The city of Boston has expended immense sums of money in sewers which are now to be reconstructed. Cities not exceeding Atlanta in population largely, and not covering a greater area of territory, have expended hundreds of thousands of dollars, and still ask for "extensions."

In commenting upon the cost of the (London) Metropolitan Drainage system, Dr. Hays, of Philadelphia, says:

"We would suggest to the conservators of the health of this city, the solution of the question. If it cost $20,000,000 and sixteen years labor to abate the nuisance caused by the Thames being converted into an open sewer, what will it cost to abate a like nuisance when the Schuylkill

*The Committee on "sewers and drains," in their annual (1876) report says: "The committee are fully convinced that the plan of sewerage commenced by them, and advocated and practically demonstrated by H. T. McDaniel, City Engineer, is a perfect success, and should be pressed at an early day to a full and complete system of sewerage and drainage for Atlanta."

This refers to the pipes spoken of above. The committee in their report confound "sewerage and drainage." The "pipes" recommended are impervious, and are not capable of becoming drains in strict technical language. If they are intended to carry off surface waters they must fail, and in fact the City Engineer does not recommend them for this purpose, but makes provision for "storm overflows," by surface drainage.

These pipes, as will be shown, can serve a good purpose in carrying away the soiled waters of the central and other portions of the city. They should be used for no other purpose. Not that they are wholly unsuited for sewers, but if "pressed at an early day to a full and complete system of sewerage and drainage for Atlanta" will cost enormously and, if possible of accomplishment, prove the very worst venture ever undertaken for the sanitary improvement of our city, as a system. The water-closet system, here implied, cannot be a "success" under this or any other plan of sewerage.

river shall be converted into an open sewer by the completion of the works now in progress on its borders."

The above question as a sanitary proposition, is submitted to those of our fellow-citizens who demand the construction of sewers, as well as to the city authorities, for consideration.

PRECIPITATING PROCESSES.

The Commission is, as stated, united in opinion on the question of the pollution of the rivulets, and the necessity of resorting to some plan or plans by which said pollution may be averted. The whole question, by this unanimity of opinion, is resolved into the following proposition: Whether, in a sanitary point of view, primarily, and, in an economical point of view, secondarily, it is better to prevent the excreta entering sewers, and to utilize it, or allow this matter to pass through the sewers, and to utilize it at the outfalls of the various sewers? In either case, unless the irrigation system be adopted, transportation by wagons will be demanded. The City Engineer, in a communication to the Commission, advocates the collection of sewage into tanks, the precipitation of the same, and the conversion of this refuse into a commercial fertilizer.* In the first place, sewage caught at the outfall of sewers is of very little value. Prof. Corfield, in his lectures on this subject, says:

"If you take sewage at a penny a ton"—the estimated value—"as containing on an average about four grains of ammonia in 100 gallons, as it does, or between five and six in 100,000 parts, then you may consider that sewage is worth one farthing per ton for every grain of ammonia per gallon it contains."

Referring to various precipitation processes, he says:

"The purification was attempted by various chemical processes, and it is still attempted to precipitate the valuable ingredients dissolved in the sewage, as well as the suspended matters. Now, there are plenty of ways in which you can clarify foul water, but you see at once that it is not easy to precipitate those particular matters that are in solution in sewage; because you see, in the first place, that the most important constituent—or at any rate one of the most important constituents, the most important from its quantity, at any rate—is the ammonia. You know perfectly well that you cannot precipitate salts of ammonia on a large scale at all from a

*The City Engineer has abandoned this scheme (see his annual report of 1876) mainly because it fails commercially to give pecuniary returns. He now advocates sewage farm-irrigation, which he must, to be consistent, abandon on the same ground, as it will be shown that sewage-irrigation farming cannot, on a large scale—the scale required—be made profitable.

dilute solution, and you will see, therefore, at once, that all attempts to precipitate the valuable matter of sewage are likely to fail, even from that cause alone. Then, in the next place, you have organic matter in solution. Now, we do not know of any substance at present which can be used on a large scale, at any rate, that can be relied upon to precipitate organic matters in solution; especially organic matters in the state in which they are in sewage, viz: in a state of very solid decomposition; and these are the substances matter which are most dangerous and which have to be separated, so that you may be prepared to find that most of the precipitating processes have failed."

Referring to the "lime process (the one recommended by the City Engineer), he makes this emphatic statement:

"A fault of the lime process is that the precipitated matter remaining is alkaline, so that much of the ammonia it contains is given off, and the next thing is that it is nearly worthless. The Rivers' Commissioners pronounced it 'a conspicuous failure,' whether as regards the manufacture of valuable manure or the purification of the offensive liquid."

Many other plans are mentioned by Prof. Corfield, all of which are condemned. He concludes the whole matter thus:

"All the attempts to prepare a solid manure out of it (sewage), whether by merely straining off the suspended matters or precipitating these, together with certain of the dissolved matters, by means of some other substances, and then letting the so far purified water into a stream, have only to be mentioned to be condemned as inefficient for the purpose, from both the economical and sanitary points of view. By them the valuable materials are not and cannot be utilized (the suspended matters in themselves being of very little value, and the matters which can be precipitated from solution being small in amount), while in several of these processes, either valuable materials contained in the substances added are in part lost, or worthless materials added in such quantity that the manure, such as it is, is of very little value; and, on the other hand, the water that it is allowed to run into contains by far the greater part of the soluble matters of the sewage, and is certainly not freed from the dangerous polluting properties that the sewage originally possessed."

If, however, the purification of sewage water could be successfully accomplished, would it be suitable for Atlanta, financially? First, there is the cost of the sewers; secondly, in all the towns where these processes have been attempted, they have been abandoned as commercial enterprises—the so-called fertilizers proving worthless, and not paying for the cost of preparing them; thirdly, the plan would require the construction of not less than five tanks, with all the costly machinery, chemicals, etc., necessary for the perfect working of the process. Then, men skilled in managing the process, with labor-

ers, horses and carts, must be employed and when all this is done, the product will be valueless. It will be seen, therefore, that the plan is both inexpedient and expensive.*

SEWAGE IRRIGATION.

Dr. Rauschenberg, of this Commission, seeing, doubtless, that the lime precipitating process would result in failure, and, at the same time, recognizing the fact (which he admits) that some disposition of the sewage at the outfalls of the sewers must be made, advocates the sewage irrigation system.

HISTORY OF SEWAGE IRRIGATION.

In discussing the proposition of sewage-irrigation for Atlanta, it will be proper, first to briefly refer to the history of this scheme for the utilization of sewage. As this has already been done by a distinguished sanitary writer of England, whose acquaintance with the subject was extensive and information accurate, his language will be used. He says:

"The history of this attractive, but groundless theory of the agricultural value of sewage is worth recording." * * * "The theory originated with Mr. Smith, of Deanston." * * * "His pursuits as an experimental farmer and cotton spinner not proving successful, perhaps from his extraordinary taste for experiments, he became a Commissioner under the first Board of Health;" * * * "and in that capacity he visited Edinburg in 1844. There he saw, in active operation, the sewage meadows which had been established many years, and which yielded, as they still do, enormous crops of rank grass, available only for dairy purposes. It immediately occurred to Mr. Smith's ingenious mind, that the sewage of all the towns of England, especially of those which were sewered under the control of the Board of Health, and which were fast getting into difficulties from legal prosecutions for fouling the neighboring water-courses, might be utilized for agricultural purposes. He thereupon proposed to irrigate grass land on the water-meadow system, and when this could not be done, to carry it by means of pipes to the convenient parts of the farm, and distribute it under a pressure of 150 feet by means of hose and jet. This capital idea was at once adopted by Mr. Edwin Chadwick, who carried the theory still further, declaring that liquid manure was *at all times* preferable to solid manure, and that it was suitable for all crops and for all soils. His theory with detailed instructions for the arrangement of pipes, etc., was circulated extensively, with all the authority and influence of the Board of Health; and it was one of the instructions of the Board that every system of sewers should be brought to one outfall, with the view of applying the sewage to agricultural purposes. Such an authoritative announcement, that town sewage contained an abundance of

* No member of the Commission advocates - but, on the contrary, all reject—the feasibility of employing any precipitating process for the utilization of sewage.

rich manurial elements, and could be profitably used in agriculture, commanded as well it might, a good deal of attention; and men of fortune of an enterprising turn, with a taste for agriculture, accepted the tempting theory—that liquid manure was superior to, and could supercede all solid manures; and a number of farms in England and Wales were underlaid with pipes, and provided with steam engines and pumps and hose, at vast expense. In Scotland too, very perfect examples were provided, one by Mr. Telfer, another by Mr. Kennedy, which, for a few years was continually cited as instances of the success of liquid manure provided by jet and hose with steam power. Both of these gentlemen grew extraordinary and repeated crops of Italian rye and grass, which were the subjects of sensational speeches at farmers' meetings, by Mr. Mechi and others. Mr. Mechi himself piped his farm, provided it with a steam engine, and announced his intention of feeding his live stock—cattle, sheep and pigs—under cover, upon boards without straw, of reducing his straw to chaff for the consumption of his beasts, and using all the manure thus made in a liquid form. Tiptree, in fact, was to dispense with solid manure and top-dressing for all its crops, and was to rely for fertility on the supply of the jet and hose. The hose and jet farm of Mr. Neilson, a Liverpool merchant, was likewise a constant subject of eulogy by the Board of Health; and Mr. Littledale, another Liverpool merchant, fitted up a dairy farm on the same plan. In Norfolk, Mr. Chamberlaine, a wealthy retired tradesman from Norwich, purchased an estate and laid it out at extraordinary expense, under Mr. Mechi's advice, with steam power and pipes; and there were other establishments which it is not worth while to name, none of them being supplied with town sewage, but all, with one exception, working after the plan recommended by the Board of Health, namely, by steam power and not by gravitation, and all attempting to cultivate all crops with liquid manure. The exception was the Rev. Mr. Huxtable, who once made as much sensation as Mr. Mechi by undertaking to teach plain farmers their business, and all the mysteries of agricultural chemistry. Mr. Huxtable employed gravitation to distribute liquid manure; but it may safely be asserted that not one of these liquid manure farmers paid a rent. Mr. Neilson became a drainage inspector, and gave up farming; Mr. Telfer failed; Mr. Kennedy, after sinking an enormous sum on Myremill, disappeared from the sensational world of agriculture; Mr. Huxtable, most extraordinary of all, not only found out, but acknowledged his mistake, and gave up the liquid system, and his idea of dispensing with solid manure, and limited his operations to a few acres of home farm. Mr. Chamberlaine's attempt at model farming proved disastrous, and eventually the pipes were taken up and sold for old iron. Mr. Littledale confined his operations to growing rye-grass for his fancy dairy, but grew corn with solid manure and top dressing of guano, and never pretended to make a profit. As for Mr. Mechi, at some mysterious date, he took to the ways of the Norfolk, and other retrograde farmers, whom had been denounced, and used his stock to tread his straw into manure. He grew his mangold's with liberal loads of solid long-straw manure and dry superphospate, and had his wheat to follow, his costly liquid manure apparatus being used as a gigantic watering-pot."

"After twenty years agitation in this manner, with all the influence of the Board of Health, and the apparently tempting results of Edinburg, there were but six places in England, in 1864, where town sewage was attempted to be utilized by irrigation, and these were, Rugby, Croydon, Carlisle, Alnwick, Malvern, Travistock and Watford. The farm at Rugby was laid out in the most approved fashion, and was managed by a very enthusiastic gentleman, Mr. Campbell, who had studied the operations at Edinburg, but, after three years of unsuccessful experience, he abandoned it, and said, in a letter to the *Times*, of the 18th of November, 1864, that he had used the sewage of Rugby ever since the formation of the works, both upon his own land and upon that of others, to the extent of 190 acres, but he was sorry to say that, in a pecuniary point of view, it had been altogether unremunerative. After this, it was taken in hand by Mr. Congreve and Mr. Walker, two other enthusiastic gentlemen, but they, also, abandoned it, and now, it is in possession of the local authorities, who work it for sanitary purposes. At Corydon, the pressure of legal proceedings for nuisance created by the discharge of sewage into the river Wandle, forced the local authorities, through the suggestive teachings of the Board of Health, to adopt the irrigation system, and, until recently, the farm has been rented by Mr. Marriage, but, for some reason or another, he has abandoned it; and, although attempts are being made to form a joint-stock company to work it, the prospects are not hopeful. Almost everywhere, in fact, the system has failed, in both an agricultural and commercial point of view, and hence there are very subdued and modified opinions of the value of sewage farming, by those who were once its most earnest advocates."

SEWAGE IRRIGATION NOT ADAPTED TO ARABLE LAND.

The lands adjacent to Atlanta are arable. Remembering this fact, an objection to sewage irrigation meets its advocates at the outset. Only upon "barren" land has it proven of any value, commercially or agriculturally. A few reasons why arable land is not adapted to the system will be given. The English authority above quoted, says:

"The great difficulty, is the utilization of it at all times, in all seasons, and with every description of soil. Water alone, under some circumstances, as in the dry, warm climates of Egypt,* China, Persia, Piedmont, Lombardy and elsewhere, has been successfully used for irrigation purposes for ages, and has given fertility to districts that would otherwise have been barren. Even in this climate, the judicious use of water at

* Under the more civilized government of the Khedive, within the last decade, English capitalists have erected large steam pumping engines upon the banks of the Nile for irrigating the adjoining lands. These enterprises have failed to be remunerative, and the steam-pumps are idle, and advertise themselves to tourists as gigantic failures. The old method is still employed by the natives with that success which has, for ages, characterized their inexpensive method of water-irrigation.

the right time has been found profitable; for, as Bacon says, 'it maketh an excellent improvement for both corn and grass, profiting them much; but it must be used in proper times and with proper soils. The same is the case with sewage, which, undoubtedly, has a somewhat higher manurial value than water. 'I would give,' says Mr. Lawes, 'two pence a ton for the sewage of London, delivered in such quantities and at such times as I required, but would not give a half-penny a ton for it, if I were obliged to take it all the year round, and have to pay the expense of subpiping and carriage through the farm, and we doubt if we would take it at any price, if we were bound to use it and deliver the water from it in such condition as to be admissible, without offense, into the neighboring streams. These facts are the great difficulties of the question; for there is no description of soil and no variety of crops that will receive sewage profitably at all times. In the frost of winter, and during the heavy rains of spring and autumn, the land is impenetrable to sewage, and it flows away, unchanged, to the nearest water-courses. During the maturity and ripening of crop, also, the use of sewage is always inadmissible. According to Mr. Lawes, the application of sewage, all the year round, as it should be applied to meet the sanitary demands of the case, is wholly unsuited to arable land; but, if a person can apply it to-day, and not to-morrow, just as he pleases, he may use it for all crops. Professor Way holds to the same opinion, for he says, 'if the farmer is bound to take large quantities of sewage at all times, he would soon decline to take it at all.' Evidence to the like effect has been given by Mr. Congreve, who managed one of the sewage farms at Rugby, and who found, after eleven years experience, that the thing was often unmanageable. 'If I had a farm,' he says, 'in the neighborhood of London, I would take sewage, if I were at liberty to have it when it suited my purpose, and I would apply it over a very limited area, at a certain time of the year; but if I were compelled to take it at all times, I should refuse it altogether.' Mr. Mechi, the champion of sewage irrigation, is evidently of the same opinion, for he says he would rather not be regulated as to the time of applying it, but would use it when he wanted it. This is the way in which it is dealt with at Worthing, at Birmingham, at Edinburg, at Carlisle, and some other places where the parties know what they are about; and this was so strongly impressed on the parliamentary committee of 1862, that they say in their report on the subject, 'that it is desirable that those using sewage should have full control over it, so that they may apply it when, and in what quantities they may require;' and they quote the evidence of Mr. Lawes, Mr. Way, Mr. Tregelles, Mr. S. Christy Miller, Mr. McCann and Mr. Miles, in proof of it. In point of fact, almost every witness who appeared before the two committees spoke of the great difficulty of managing a sewage farm so as to get rid of the sewage at all times."

"We have the valuable testimony of Dr. Voelcker, who is one of the highest authorities on this subject, and who says that nowhere have experiments on agricultural subjects been more extensively tried than in England; and seeing the great success of irrigation with liquid manure in

Flanders, where the soil is almost barren, men have thought that the system ought to be equally successful in this country." Now, "according to Dr. Vœlcker, when the soil itself contains the elements of fertility, sewage has no more value than so much water, and will not remunerate the farmer for the expense of its application. In the case of soils naturally poor and *barren*, the conditions, he says, are altogether different, for then a copious application of town sewage will produce abundant crops of grass, where nothing else will grow of any agricultural value. In commenting on these remarks of Dr. Vœlcker, the editor of the "Agricultural Gazette" (Mr. Morton, who is now one of the Rivers' Pollution Commissioners), said 'that the lecture of Dr. Vœlcker, reported in the Gazette, has probably done more than anything hitherto made public to determine the vexed question of the true value of town sewage, and to dissipate many flattering illusions entertained upon the subject; for he appears clearly to show *that town sewage is of little value as an application to* ARABLE *land or for horticultural purposes.*'"

SANITARY OBJECTIONS TO THE SYSTEM.

Dr. Letheby, one of the most learned of English chemists and sanitarians, made the subject of sewage-irrigation a special study, and visited personally every irrigation farm in England and Scotland. The "Medical Press and Circular," in compiling the facts, after careful study of his notes, says:

There are three classes of effects which render sewage-irrigation more or less dangerous to the public. In the first place, the emanations are offensive and are productive of pythogenic (zymotic) diseases. In the second place, the percolation of sewage into subsoil water, and thence the third place, the distribution of undefecated sewage charged with the into springs and wells, is not unlikely to be a source of danger; and in ova of intestinal and other entozoa, is certain to produce disease in man and animals. As regards the first point, namely, the offensive and morbific character of sewage emanations, especially in those cases where the undefæcated sewage is distributed in large quantities upon the land, there is abundant evidence. At the Craigintinny Meadows, near Edinburgh, the stink is hardly endurable. To use the words of Dr. Lightfoot, who was stationed at the neighboring cavalry barracks in 1868, "Those fields are certainly a source of nuisance to those living in barracks, from the offensive emanations given off from the open ditches conveying the sewage, and also from injudicious flushing of the fields, for the stench in the barracks is sometimes sickening." At Norwood and at Beddington the Croydon sewage-farms are the subject of constant complaint, and the neighboring houses and property are greatly damaged in value on account of it.

Many other farms are noticed with similar results.

Dr. Copeland, in his remarks on the paper of Mr. Cook on the "Treatment of Sewage with Lime," stated that in his opinion the effects of sewer gases were never so bad as when sewage was spread out upon land. "The instances which have already presented themselves of the malarious effects

of sewer gases are sufficient to create alarm, and to show that under some circumstances the proximity of a sewage-farm is not altogether devoid of danger."* Another instance of the dangerous effect of this sewage-irrigation occurred at Shaftesbury. The town had recently been drained by a person of no practical knowledge, who carried the sewage into the ditches and ponds of the neighboring fields. In less than a year one-eighth of the population was attacked with typhoid fever, and the results were so serious that Dr. Letheby was requested by the local authorities to inquire into the matter; and he reports that of 3,500 persons who formed the population of the place, 448 were attacked with the fever.

Many other instances could be given. Very recently, in the spring of 1872, an outbreak of scarlet fever at Haileyburg College, near Hertford, was traced by the medical attendant, Dr. Elin, to the offensive emanations from a garden and field saturated with sewage. But why multiply examples of this kind, when, to use the words of Drs. Buchanan and Radcliffe, in their report on the systems in use in various towns for dealing with excrement, "The propagation of certain epidemic diseases, especially cholera, typhoid fever, and diarrhœa among communities, as the result of excremental pollution of air and water, is one of the best established facts of sanitary science. The chief object, indeed, of sanitary practice during the last fifty years has been to prevent the infection of the air with excremental effluvia; and the most notable fact in the present century has been the recognition by Dr. Murchinson of the true cause of typhoid fever in the poison contained in sewage emanations." Sewage contains myriads of ova of intestinal entozoa. "If," says Dr. Coffold, "without due consideration you adopt any one of the gigantic schemes of sewage-irrigation now in vogue, you will scatter these eggs far and wide; you will spread them over thousands of acres of land." These ova are taken into the flesh of animals through the stomach, and when eaten by human beings produce the tape-worm.

In reference to these irrigation farms, the editor of the "Medical Gazette," says:

"We have drowned the materials intended for the food of the plant in water that ought to flow unpolluted into the river, and then we wonder that the filthy mixture defies our skill. In some cases, as at Edinburg, all sanitary considerations are abandoned and the sewage is allowed to flow upon the ground in such enormous quantities as to convert the locality into a stinking moras which is a public nuisance; besides which, the effluent water is so foul as not to be admissable into any decent watercourse, and therefore runs directly into the sea. On the other hand, when sanitary results are aimed at, as when the sewage is sprinkled upon the land, as at Rugby and Paris,† the agricultural products were so unprofita-

* The history of the late epidemic of yellow fever at Savannah fully sustains the opinion given.

† "The sewage-farm referred to above, was located on "arable" land and proved as stated, a failure. More recently other farms have been established with better success. Speaking of the sewers of Paris, a recent

ble that, notwithstanding the ardor and strong faith of its advocates, it was at last summarily abandoned. So that whether we wish to realize commercial profit or sanitary success, we are alike in a difficulty. * * * It is abundantly evident, indeed, from the facts before us, that *sewage-irrigation can never be successfully practiced except under particular circumstances, as where the land is far removed from human habitations; where the soil is so porous as to admit of free and almost unlimited percolation; where the effuent water can be discharged at once into the sea;* * * * * and where the produce of the land—the rank sewage grass will find ready sale for dairy purposes. On the other hand, the disadvantages of sewage-irrigation, as now practiced, *are so numerous and so formidable as actually to appal us.*" He concludes the matter thus: "All these considerations lead to the conclusion that the present method of distributing sewage upon the land *is eminently unsatisfactory, for it is wasteful, it is inefficacious, it is expensive, and it is dangerous.*"

SEWAGE IRRIGATION A FORCED CONDITION.

In sanitation, sewage irrigation was an "after thought." It received the advocacy of public health officers as affording an escape from the difficulties which the pollution of streams involved the towns of which they were the health-guardians. With the water-closet system in operation, at great expense, it was found that some means must be employed to save the system, and, at the same time, avoid the fouling of the rivers into which the sewage was discharged. Sewage irrigation was proposed. It was a forced condition. With many towns, it was a question of resorting to this system, or of giving up the water-closet system altogether. If the water-carriage system should be adopted in Atlanta, then sewage irrigation must follow as a necessary sequence. There can be no escape from

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author says: "The great collectors (sewers) used formerly to discharge all their contents into the Seine. They now, by aid of a reservoirs and a steam-pump, spread fertility over the once sterile (*barren*) peninsula of Gennevilliers. This tract is formed by an immense bend in the Seine, between Neuilly and Chaton. It used to be the dreariest and most unproductive spot that one could well imagine. The soil was poor and stony, consisting of sands and pebbles scarcely hidden beneath a thin film of vegetable mould."

The City Engineer refers approvingly to this farm. It will be seen that in the first place, the land was "barren;" and in the second, that the sewage of Paris contains only the urine and soiled waters of the city.

It is not a sewage-farm proper.

It is also stated that the Villageres have petitioned the authorities to have the nuisance stopped, as they alledge that the soiled waters have rendered their homes unhealthy.

this conclusion—hence the advocacy of sewage irrigation by Dr. Rauschenberg, of this Commission.

SEWAGE IRRIGATION NOT INDORSED BY SANITARIANS.

The International Medical Congress, of 1876, composed of the ablest sanitarians of America and many of those of Europe, refused to indorse sewage irrigation. In the proceedings of the Congress the following action is reported:

"A proposition AFFIRMING that the sewage irrigation of *arable land, well under-drained* is, where practicable, the most economical method of disposal of sewage, and is free from well-grounded sanitary objections, was not concurred in by the section, which declined to express an opinion upon the subject, and considered it still open to investigation."*

Thus, after thirty years of trial of sewage irrigation, the question remains "open to investigation," which is the verdict rendered by a medical congress of sanitary experts! Coming from the advocates of sewerage it amounts to a condemnation.

By referring to the language of the resolution, it will be seen that the subject was presented in a form to meet the requirements of American cities—cities like Atlanta, surrounded by not "barren," but "arable" land.

1. The land was to be "arable."
2. "Well under-drained."
3. That, "when practicable," declared to be,
4. The most economical method of disposing of sewage."
5. That, under these circumstances, it was "free from well-grounded sanitary objections."†

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*The editor of the Boston "Medical and Surgical Journal," in a review of the State Board of Health, in reference to the advocacy of sewage-farm irrigation, makes the following criticism. "Notwithstanding the effectiveness of such advocacy as just quoted, it is obvious, if we may judge by the current literature, that sewage-farming is not growing in favor, and that it is on the defensive. * * There are so many practical difficulties in the way of sewage-irrigation, touching topography, the selection of a suitable soil, the imperative need of intelligent and vigilant supervision, and the demands of the seasons, that engineers and sanitarians naturally turn first to less complicated and less exacting methods."

†The City Engineer, in his annual report, says: "The pollution of streams can be prevented by irrigation, which does not injure the health of those using it in farming districts, but on the contrary pays handsomely," which shows a difference of opinion between that gentlemen and the congress of sanitary experts. In order to make it pay, how would he manage these farms near Atlanta, on "arable" land? What would he

Thus, by the testimony of the English sanitarians already referred to, and the verdict of the International Medical Congress, cities situated like Atlanta cannot possibly employ their sewage for irrigation purposes, without a total disregard of the laws upon which are founded the principles of sanitary science as well as the best interests of their people.

CAN THE SYSTEM BE MADE PROFITABLE FOR ATLANTA?

Having shown the sanitary objections to sewage-irrigation, which overshadows every other consideration, it will be proper to notice the practicability of making it profitable for our city. That it can be made so, has been, incidentally, shown to be impossible. It was proven by the testimony of the ablest sanitarians that sewage cannot be used, the year round, on arable arable land, and give profitable returns.

In determining the question, it will be necessary to refer to the commercial and agricultural value of sewage. The English authority already referred to says:

In the evidence before the Select Committee of the House of Commons in 1862, the value of it was variously stated at from ½d. to 9d. per ton. The Earl of Essex thought it should be supplied to the farmer at rather less than a penny a ton; but Messrs. Lawes, May, and Morton valued it at 1d; Liebig and Vœlcker at 1¾d; Mechi, Hoffman, and Witt at 2d. In reality, however, no one will buy it at any price, unless he has the opportunity of using it when he pleases, and then he will pay at the rate of 5s. to 6s. per acre for it, provided the local authorities will deliver it upon his land in the quantity required and whenever required. A farmer would be glad to take water at this price, for there are seasons when it is desirable to have an abundance of moisture to help forward the growing crops, and especially grass upon meadow land. Even in the case of Craigentinny meadows at Edinburgh, where the yield of grass is enormous, the sewage is not used continuously, but diverted from the land to the sea when it is not wanted; and although they realize in good seasons from £20 to £30 worth of green produce per acre, yet the quantity of sewage used is not less than from 10,000 to 13,000 tons an acre per annum, which, at an average price of £25 for the produce, is less than half a penny a ton, irrespective of rent and farming expenses. At 1d. per ton the sewage would cost £62 10s. a year. In reality, however, it costs nothing, and the same is the case at Worthing, Rugby, Croydon, Carlisle, Aldershot, and elsewhere. So disinclined, in fact, are the farmers to take sewage at any

do with the sewage during the winter and spring months? If the sewage cannot be suffered to soak into the soil the year round, and make crops, will he turn the sewage into the rivulets during these months? In the one case he will fail to make a crop remunerative, in the other, he will pollute the branches. Either horn of the dilemma is fatal to his theory.

price, that the local authorities are obliged to appropriate land on their own account, when, for sanitary purposes, they resort to irrigation.

This brings us to a question of great practical importance, namely: how much sewage can be profitably and safely applied to a given area of land? On this head, as on every other, there is the greatest difference of opinion, although it results generally in the fact that the sanitary and commercial aspects of the question are widely opposed, it being impossible to realize agricultural success with a perfect deodorization of sewage; for, in one case a *large* proportion of sewage is required, and in the other a *small*.

Mr. W. Hope read a paper "On Sewage Irrigation in Connection with Public Health," wherein he stated that in most cases the sewage farms of England were, as Dr. Letheby and Mr. Hawksley had described them, *pestilential swamps;* and this he attributed to the application of sewage in too large quantity, especially during the night, when plants could not utilize it. He therefore recommended that sewage should be sparingly used—*an acre of land being allotted to every twenty or thirty persons*, as it seemed exceedingly doubtful whether, having regard to the commercial side of the question, it would be practicable to utilize the sewage of more than twenty or thirty persons per acre over a term of years. This is at the rate of from 1,000 to 1,500 tons of sewage an acre per annum; and it is, we believe, the quantity used by Mr. Hope, upon the 121 acres of Breton's farm, near Romford, of which he is the lessee. A like opinion was entertained by Mr. Westwood; for he said, in his evidence before the Parliamentary Committee, *that when more than* 1,500 *tons an acre were applied to the land* (*clay*) *it ran away into the drains and fouled the streams.*

This would be the case with a sewage farm near Atlanta.

"It comes, therefore, to this, that after an experience of nearly thirty years, in every variety of situation, season and soil, with all the enthusiasm and diligence necessary for success, the, so-called, practical men are unable to declare definitely what quantity of sewage can be safely and profitably applied to a given area of land; for in actual practice, it ranges, as we have seen, from 100 tons an acre per annum, to 40,000 tons; or, to put it it the form of acreage to the population, it ranges from two persons per acre to eight hundred persons. One thing, however, is conclusive, and that is, the diametrically opposite conditions of sanitary and agricultural success, for while, in the one case, a limited supply of sewage to the land is necessary, in the other it must, at certain times, be almost unlimited. To be safe, in fact, as regards freedom from nuisance, the land must never receive more than from 1,000 to 1,500 tons of sewage per acre per annum; whereas, for commercial profit it must never have less than 5,000 tons an acre. In the former case, it represents a maximum of thirty persons to an acre, and in the latter a minimum of one hundred persons."

The Massachusetts Board of Health says: "In 1865, the idea had become quite prevalent that large fortunes were to be made both from the precipitated manure of sewage, and by utilizing it on irrigation farms, in spite of repeated statements of authoritative bodies to the contrary."

"The Metropolitan Sewage and Essex Reclamation Company, was incorporated by special act of Parliament, to raise a capital of over two million of pounds, to reclaim from the sea the enormous plats at the mouth of the river Thames, and to utilize the sewage upon them. The enterprise failed."

"Irrigation, to be carried on so as to avoid offense, is not a cheap process. * * If irrigation, with sewage, on a large scale (the scale required for the sewage of Atlanta) has been uniformly unprofitable in other countries, it is likely to be still more so here." * * "Except under favorable natural conditions, (as has been shown, these conditions do not exist near Atlanta,) sewage, on account of its extreme dilution, (the only way it can be used for sanitary purposes,) is expensive to handle, and is of little value as a compound with other fertilizers. The sewage of most English towns is so diluted that one ton of Peruvian guano has the same value as 1,250 tons of sewage. In American cities, where twice as much water is used, its value would only be half as great." "German investigators, and especially Varrentraff, have insisted that the merchantable aspect of the question must be ignored, and purification of the sewage must be rendered complete on sanitary grounds alone, whatever the cost."

It will be proper to add that the Royal Commission (England) appointed to investigate and report upon the practical working of the Government irrigation farms, 1875, asserts that *these farms have in every instance proven commercial failures and are not paying expenses.*

The number of acres of land in order to comply with the sanitary requirements of sewage irrigation, leaving out of view, the absence of the conditions already shown to be necessary for the success of the system, will be seen from the foregoing. There must be one acre of land to every 30 persons. Estimating the population of Atlanta at 40,000 persons, it would require 1,333 acres. The purchase of this quantity of land at the moderate price of $30 per acre would cost $40,000, and the farms to be properly terraced, "underdrained," ditched, etc., would cost not less than $20,000 more, making a total outlay for the purchasing of land and the preparation of the same for sewage irrigation of $60,000.

No less than four (two of the five rivulets unite within a short distance beyond the city) farms would be required upon the rivulets. It is evident that either the sewers of the different outlets must be carried a long distance from the city in order to have the sewage taken sufficiently high to irrigate the terraced hill-sides, or there must be four steam-pumps to pump the sewage upon the terraced farms. If the latter is done

there must also be four reservoirs constructed to catch the sewage in order that it may be pumped up upon the farms. In either case the cost will be immense. Each of these farms under control of the city must have its superintendent, laborers, horses, carts, tools, etc., and added to these items the cost of sewers, steam-pumps, etc., to put the system in operation. This scheme, as the tax payers will see, must share the fate of the once proposed but now abandoned plan, of "precipitating" the sewage at the outfalls. And as other methods—as will be shown—will not require the enormous sums of money for sewers, steam-pumps, etc., and no greater number of men, horses and carts, it will be pertinent to ask, why lose the valuable manurial matters by passing them through sewers? If the sanitary problem of Atlanta demands the manipulation of these matters *some where* as an essential factor in its solution, *why not begin when they are in the only condition in which they can be converted into valuable fertilizers?*

In contrasting the earth-system with that of water-carriage, the editor of the "Medical Press and Circular, has this to say:

"The advocates, in fact, of the present water-carriage system assert that water is a vehicle which will carry the filth, by the natural power of gravitation, to any place where it is wanted, and it carries it more cleanly and more immediately than can be done by any organization of man and horse and cart. The manure (they say) which must be collected from town privies by an army of scavengers, and distributed from the depot by barge or rail, to be afterwards loaded in carts and spread abroad by hand, and carried by the plough, might, if water were the carrier be virtually self-borne to the very place where it is wanted -taken almost direct from the water-closet to the field and there washed in at once with really no labor at all, among the very roots of the plants it is to feed. But, remarks the editor, all this assumes the total absence of inconvenience and danger from misadventure of the soil between the closet and the field, and it assumes, moreover, that the ground is always ready to receive it, and the growing crop to appropriate it; that there will, in fact, be no escape of noxious effluvium into the air, or of foul matters into the earth or into the neighboring water-courses. Experience, however, has shown that these assumptions are never realized in practice, and that the greatest difficulties of the water-carriage system are created by the very circumstances which are thus assumed to be non-existent; that the vehicle, which is said to be so admirable a servant, *is really a tyrannical master, defying all our efforts to control it; and hence there are many large towns already sewered which will not accept this vehicle, notwithstanding its plausible show of convenience.*"

SYLLOGISTIC ARGUMENT AGAINST SEWAGE IRRIGATION FOR ATLANTA.

For the agricultural success of sewage irrigation every one of the following *conditions* are necessary:

a. The land to be used must be "*barren*" and not "*arable.*"

b. The land must be "*sandy and porous,*" and not a "*clay soil.*"

c. There must be large streams for the effluent waters.

d. The sewage must be applied, sometimes, in *smaller*, and sometimes, in *larger* quantities during different seasons of the year.

e. The sewage must not be applied continuously to arable land the year round.

f. The sewage must be used on a "large scale."

Now, (*a*) the land near Atlanta is not "*barren*" but "*arable;*"

(*b.*) Is a *clay* and not a "*sandy* and *porous*" soil.

(*c.*) There are no large streams for the effluent waters.

(*d.*) The sewage cannot be applied, sometimes in smaller, sometimes in larger quantities during different seasons of the year.

(*e.*) The sewage must be applied continuously to the arable land near Atlanta, the year round.

(*f.*) The sewage must be used on a large scale.

Hence, as all the conditions named are wanting—no one of which must be absent—therefore, sewage irrigation cannot be made an agricultural success or profitable for Atlanta.

In addition to all these conditions, sewage irrigation must still stand condemned (independent of the enormous cost in inaugurating the system) as it cannot be made both a sanitary and an agricultural success, on a large scale, at one and the same time. One acre of land to every 30 persons *is the sanitary requirement;* one acre of land to every 100 persons *is the lowest estimate for agricultural success—i. e.* upon barren land, the only land where success is possible.

In the consideration of the water-carriage system the

DEATH RATE OF CITIES

employing this system has been referred to. In a communication to the Commission, the City Engineer refers to the lessening of the death-rate in towns of England, caused, solely as supposed by the water-carriage system. That this result

has been brought about, to some extent by water-carriage, is undeniable. The contrast in the statistics educed, is drawn between water-carriage towns and midden towns. The midden-pit system is sure to pollute wells and springs, and is infinitely worse than a system of sewage. The statistics referred to, also show, that the reduction in the death-rate of these sewered towns was largely caused by the improvements in the drainage proper. They show a decrease mainly in those diseases induced and increased in number by the wet, water-saturated subsoil—such as scrofula, phthisis, rheumatism, etc. As remarked, the marked improvement in the death-rate of these diseases was owing to drainage—the soil of England being porous, extremely liable to fecal pollution, and besides requiring drainage of the subsoil for health. The increased healthfulness of these English towns is due also to new and purer supplies of water, uncontaminated with the sewage of sinks or from other sources.

The statistics of American cities show that sewered towns, located favorably as to surface drainage, have not as low a death-rate as those cities similarly located, but which depend almost exclusively on surface drainage and partial conservative methods. Baltimore as contrasted with Nashville, may be mentioned, the death-rate in the former city being much less than in the latter.

The following tabulated statement of the death-rate of European cities is given. It shows that London, one of the model sewered city of the world, the excrement of which is passed through the sewers, has a greater death-rate than Paris, which is also one of the model sewered cities of the world, but which excludes fecal matter from its sewers, and deposits this refuse in large cess-pools. The advocates of sewers for Atlanta are in the habit of calling attention to these cities by way of contrasting the sanitary superiority of London over Paris, due, as they affirm, to the difference to the methods of disposing of their refuse matters.

These statistics, which have been obtained from the most authentic sources accessible, represent the mortality in some of the chief cities of the world, during the past four or five years:—

	Number of Years.	Average Population.	Average Total Mortality.	Average Death-rate per thousand.
Vienna	5	648,560	20,424	31.42
New York	5	994,458	29,601	29.93
Berlin	4	950,000	28,420	29.91
London	5	3,284,488	76,741	23.33
Paris	4	1,851,792	42,724	23.06
Philadelphia	5	744,831	16,573	22.27

Rochdale, using the pail-system, has a population of 67,754, and has a death-rate of 21.19.

SHALL WE HAVE NO SYSTEM?

If the foregoing review of the difficulties, both in sanitary and financial points of view, as to the adoption of the water-carriage system for Atlanta, be found to be correct, then it follows that other methods of disposing of excreta must be employed. It has been granted, for argument sake, that all the conditions existing, the water-closet system, in the end, would prove the best for our city. If, however, these conditions do not exist, what shall be done? Shall we have no system? Shall we allow filth to accumulate, to poison our people? Would this be wise?

Dr. Child puts the case in the following way:

"We desire some way by which we can be freed from these matters at once, after they are thrown outside the house. Hence they are neglected until some fearful sickness comes to arouse. But our food is prepared once in six hours; we bathe daily; we do not forget to sleep; we cut our hair monthly; we ought to pay our bills quarterly; we visit our friends occasionally; the toper never forgets his dram; we raise an alarm if our house is on fire; then, why, in the name of common sense, should we not remove those matters from our dwellings, which, remaining, endanger the health and lives of ourselves and those we love?"

All sanitarians recommend some method of conservancy, when water-closets are impracticable; while others, all things being equal, prefer conservancy—especially in small towns—to the water-carriage system. Hence, we are not closed up to the adoption of any one system, for other systems give excellent sanitary results.

Dr. John Simon, in speaking of bad privy arrangements—such as midden-pits, bog-privies, etc.—remarks:

"I described at some length the extremely filthy and dangerous arrangements which frequently, or, I fear, I should say generally, exist in places where water-closets are not in use. Modern experience, however,

has shown, and the fact is of the highest sanitary importance, that such arrangements are not the necessary alternative to a system of water-closets; but that failing a water system, both large and small populations can obtain, under other and amended systems of privy arrangement a complete, or comparatively complete, freedom from excremental nuisance and injury."

Now, Dr. Simon, is, under favorable circumstances, an advocate of the water-carriage system. He further says:

"The broad results which I wish to bring into relief, as for legislative purposes all important, are: first, that local authorities, willing properly to exert themselves for the prevention of excremental nuisances, have at their disposal various ways by which that end can be more or less perfectly attained; and secondly, that a law, imperatively refusing to tolerate such sorts of nuisance, does not, in its relation to local authorities, represent a claim for wonderful exertions or lavish expenditure, but a claim which, even where circumstances are least favorable, can be easily, and ought to be cheerfully met."

Viewed from every point, the condition of our city demands immediate action for its sanitary improvement. No delay should be allowed by the proper authorities, and the experience of Dr. Simon warrants legislative procedure for the attainment of so important an object and should stimulate the General Council to prompt and decisive action. Atlanta having no system, is in the best possible condition to select the one suited to her sanitary wants, and her people should demand the enforcement of that system which will give the greatest sanitary security, by proper legislative action.

CONSERVATIVE METHODS.

It will not be necessary to consume time in a description of all the plans of conservancy. After a careful consideration of these methods, the following have been deemed the best for Atlanta:

1. The cemented vault system.
2. The earth-closet system.
3. The Rockdale pail system.

CEMENTED PRIVY VAULTS.

It is believed the construction of properly made cemented vaults, for the sanitary requirements of Atlanta is founded upon correct sanitary principles. On many of the premises in the central portion of our city, this system can be made available, as it certainly may be in the other parts of Atlanta.

The vaults should be made small to insure frequency of

removal of their contents; they should be impervious to water, to prevent the escape of the liquid contained. They should be detached, if possible, from houses, and always properly ventilated and disinfectants used frequently and systematically.

This plan, slightly modified—in favor of the system advocated—is employed in Paris and some other European cities. In this connection the views of Dr. Bliss, of Washington city, and a member of the Board of Health of the District of Columbia, will be given. In a letter to the writer he says:

> In my judgment, the system best adapted to aggregate communities, and especially inland cities like Atlanta, and which will contribute to the highest degree of salubrity, is the introduction of vaults properly constructed, below the surface (which secures a low degree of temperature), and the pneumatic process. The vaults should be of a size to contain not more than two barrels of excrement, as large vaults, however well constructed, are liable to become defective, causing leakage of their contents. The material of construction should be quarried stone or brick, laid in Portland cement and lined with the same material, so as to preclude the possibility of percolation of the fluid excrement.

The objections urged against the plan suggested are:

1st. That removal of the contents of vaults is too long delayed.

2d. That the removal of vault contents by "hand and bucket," and their transportation in open carts, is indecent and offensive, if not dangerous.

In answer to the first objection, it is admitted that large vaults, similar to those used in some of the cities of Europe, are objectionable. The vaults in these cities are placed under the houses, which should always be avoided when possible; are not sufficiently ventilated, and are of such large capacities as to require the removal of their contents only once in twelve months. They are made large for the reason that removal of their contents is a work so laborious and offensive as to be done as seldom as possible.

The second objection is also a serious one, and if there were no means of overcoming it, would be sufficient to condemn the plan suggested. This objection is perfectly removed by the pneumatic process. By these machines the contents of vaults can be removed rapidly, economically, without offense, and in the busy hours of day.

ODORLESS EVACUATING MACHINES.

There are four or five different models of these pneumatic machines manufactured in the United States, under as many patents. One is made at Baltimore, others at Philadelphia, New Haven, and Chicago. The "Odorless Evacuating Apparatus," of Baltimore, is in successful operation in Boston, Providence, Pautucket, New York, Brooklyn, Jersey City, Newark, Elizabeth, Philadelphia, Wilmington (Del.), Baltimore, Washington, Georgetown, Alexandria, Norfolk, Richmond, Charleston, Savannah, New Orleans, Memphis, Chicago, Grand Rapids, and Detroit.

This apparatus consists of a portable pump with valves of peculiar construction; an air-tight tank and a charcoal furnace, in which the noxious gases are consumed.

Through the kindness of the Baltimore Orderless Apparatus Co., the illustrations of this apparatus are given in this report:

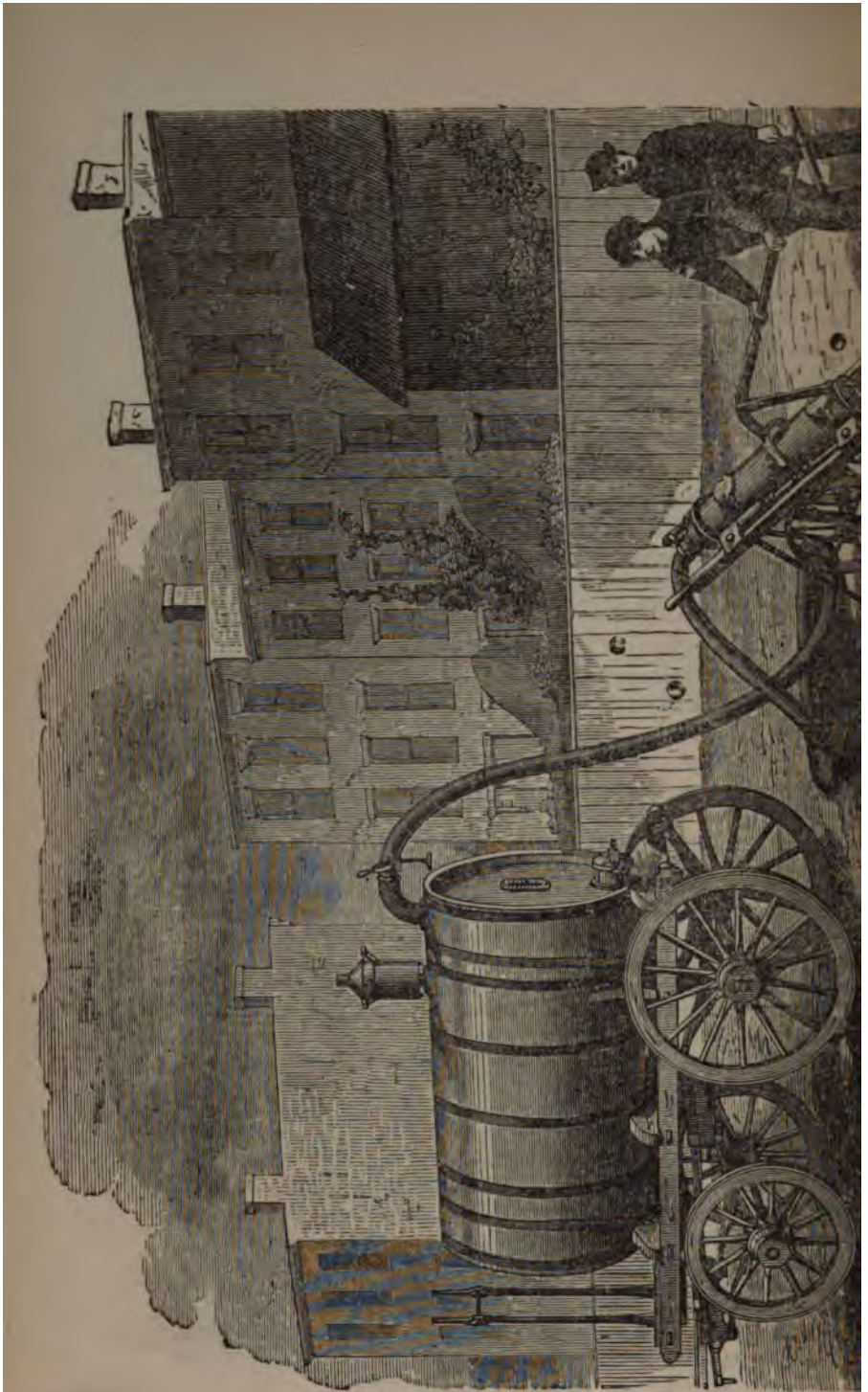
From the "Scientific American Supplement" the following explanatory extracts are taken:

"The pump is a very simple single-acting one, so arranged as to make a continuous reception and discharge of the matters in the direct line through it, and so effective is it for the purpose designed that it freely permits the passage through it of any conceivable kind of material which might enter it, as stones, sticks, shavings, rags, ropes, bottles, bones, and what not; and in known cases an entire pair of heavy cloth pants and a full sized army blanket have been pumped through it easily; and perhaps one of the most remarkable tests to which it has been put is that of pumping through it some fifty feet of a large sized rope, passing at the same time in a perfect manner liquids or semi-liquid substances. The construction of the pump will be readily understood from the engraving, fi. 2, and the larger figure illustrates equally well the application and operation of the entire apparatus.

The removal of night soil in airtight receptacles is not confined to the use of a large tank on wheels, as shown in fig. 1; it is similarly forced into barrels of ordinary dimensions, in which form it becomes, when sealed, a merchantable package, and is in form for handling and transportation to a distance with great facility.

A number of patents are in existence for improvements, both in the "forcing" and "vacuum" systems, the principal ones, some 20 in number, being controlled by this Company.

The Company has an excellently arranged plan for discharging the contents of the large tanks into the airtight barges or car tanks, just as is done in the transportation of coal oil; and in the transfer of the material to either of these the same deoderizing apparatus is employed as that already described.



THE ODORLESS EXCAVATING APPARATUS.

Fig. 5

Fig. 5 shows the apparatus as used in the "barrel" system. To complete this system and render it applicable to the most extreme cases, as to difficulty of removal of the material, the plan shown in fig. 6, and called the "pitting" apparatus, is resorted to, and consists simply in covering the approaches to an outhouse with a kind of canvass awning, from which is led a flexible tube to the deodorizer, to destroy the effects of the gases and odors generated in the disturbance of the material inside. The awning likewise excludes the operation from observation. This plan is only resorted to in cases where the contents of the vault has become from long standing or other causes so unyielding as to preclude the use of the pump, in which case it is simply removed by digging, which, in its comparatively solid condition, is not by any means so disagreeable an operation to the workmen inside the awning, as was the old bucket system with the more liquid contents. In this way it is removed in the daytime without offence to either sight or smell. It is rarely necessary to resort to this plan, but it becomes a necessary adjunct to the completion of the system adopted by this Company.

FIG. 6.—THE PITTING APPARATUS.

The pumping and "pitting" apparatus constitute a complete system for cleaning sewer traps and basins without offence to sight or smell, avoiding the obnoxious features of an operation incident to all cities where sewers are used. In this case a specially constructed awning is employed, covering the mouth of the sewer and concealing the entire operation, while the noxious gases are drawn off and consumed as already described. This system is now largely in use and in fact becoming extended throughout the country.

With the tanks and apparatus kept in a cleanly and sightly condition, as they pass in view of pedestrians and residents upon the route, there is no offence even to the fastidious; and certainly the nicely painted tanks and trucks which are daily seen perambulating the streets of Philadelphia and other large cities are as unobjectionable in every respect as an ordinary watering cart."

The President of the Board of Health of the District of Columbia, (Dr. Cox) in his report of 1874, says:

"This apparatus in its successful operations seem to leave nothing to be desired. * * * A contract was entered into with the company for one year. * * * At the expiration of the year * * * a contract was entered into with the same parties for five years. * * * The Board of Health and the community especially, deserve to be congratulated upon the successful reform instituted and steadily maintained in connection with the disposition of night soil. While the cities of Washington and Georgetown are thus relieved of the most oppressive of all nuisances, the death-rate has been sensibly diminished."

The Board of Health of Wilmington, Del., says:

"From every quarter our inquiries were met with the same answer—assurances favorable to the merits of the machine."

The Board of Health of Philadelphia, says:

"Its advantages are manifold. The work can be performed in the day time; it is a cleanly and orderless method from begining to end, and it is economical and practical."

Dr. Jas. A. Steuart, Health Commissioner, Baltimore, says:

"This admirable invention entirely does away with the nuisance of the old plan, and in a sanitary point of view, is destined to prove an inestimable blessing."

The Boston Board of Health, says:

"By this process vaults may be emptied on a midsummer morn without offense. The tank, containing 640 gallons, may be filled in from 10 to 15 minutes."

Dr. Cox, in response to inquiries by the writer, says:

"In reply to your favor, I have to say the Odorless Evacuating Apparatus company has been in operation in this District for a number of years—indeed ever since the horrible bucket system was abolished by the

Board. It has, I am happy to say, proved itself in every respect a complete success. The operation of removing excreta from privy vaults and boxes is carried on in the day time without the least possible offense—the vaults of the company being as little noticed or noticeable as the ordinary express wagons that circulate through the streets. The expense to the citizens is precisely the same as under the old system, while the advantages are incalculably greater. The O. E. Apparatus, is in fact, an indispensable necessity here, as it will be in any city where its merits are fully tested."

The Board of Health of Detroit, responding to the writer, says:

"It is a splendid contrivance, and does its work without any smell, or offense. The price does not exceed 12½ cents per cubic foot of material removed. The system is a success, under all circumstances and as economical as any, more especially so in a sanitary point of view."

The Health Officer of Chicago writes:

"So far the machine has given great satisfaction."

Prof. Chandler, President Board of Health, New York city, writes:

"The Odorless Evacuating Apparatus does its work remarkably well, and gives entire satisfaction."

The Health Officer of New York, writes:

"It has met with our entire approval. * * * The work is done in broad day and in the busiest thoroughfares."

President Board of Health of Boston, writes:

"We have had it in use in our city fifteen months and upward, and it gives satisfaction."

He thinks the Bradley machine superior to any other, and of this says:

"I do not hesitate to say that this apparatus (the improvement) is a very exellent one and very cheap."

Dr. Steuart, Health Commissioner, Baltimore, writes:

"The Odorless Evacuating Apparatuses do their work perfectly; are durable; cost less than old system; are eminently desirable in a sanitary point of view; and do three-fourths of all the work in the city with success."

Dr. H. Jones, Secretary of the Board of Health of Memphis, writes:

"Have used machines for about two years, and consider them far superior to any yet invented. In fact, it leaves very little to be desired. * * It does its work rapidly and effectually. They can fill a 640 gallon cask in ten to fifteen minutes, and charge two cents per gallon."

Dr. Cabel, President Board of Health of Richmond, Va., thinks "the pneumatic process offers the best means of remedying the evils under which Atlanta now labors."

Dr. Hawley, Health Inspector of Elizabeth, writes:

"The adoption of the Odorless Evacuation Apparatus by the city of Atlanta would prove a success as a matter of economy, as well as doing away with the other plans of removal."

Health Officer, Newark, N. J., writes: "The Odorless Evacuating Apparatuses are in successful operation in this city. * * The refuse material the company utilize by having dumping grounds outside the city limits, at various points, where they manufacture a fertilizer."

The Massachusetts Board of Health (1876), in referring to the odorless machine, says:

"For a town of a population not exceeding 10,000, the right of use during ten years can be had for $300, and a complete set of apparatus for $350 more. Thus equipped, any town, either by its own teams and workmen or by contract, might thoroughly, inoffensively, and quickly empty, by daylight, not only privy-vaults and cesspools, but 'pond-holes,' stagnant pools, etc. Odorless transportation, in manageable packages, forms part of the system, so that the matters removed can be offered 'in lots to to suit purchasers,' in the form of valuable fluid fertilizers. Surely a town making this investment could depend upon receiving in cash a sum sufficient to keep the apparatus in order and pay interest on the $650 expended."

The cost of the system may be gathered from the foregoing.

DRY-EARTH SYSTEM.

The dry-earth system is better known than any other conservative plan in this country. Its advantages of applicability are apparent in the suburban portions of our city. The transportation of the earth—which is one of the best deodorizers—after suitable closets were arranged, would be the only expense (and in nearly all portions of the city this need not be an expense, as the earth should be taken from the gardens) of consequence, as the manurial earth would be immediately applied to gardens, increasing their productiveness and improving the health of the city.

This system has been somewhat extensively used in England. The advantages of the system, as summarized by Dr. Buchanan, are as follows:

1. The earth-closet, intelligently managed, furnishes a means of disposing of excrement without nuisance, and apparently without detriment to health.

2. In communities, the earth-closet system requires to be managed by the authorities of the place, and will pay at least the expense of its management.

3. In the poorer classes of houses, where supervision of any closet

arrangements is indispensable, the adoption of the earth system offers especial advantages.

4. The earth system of excrement removal does not supersede the necessity for an independent means of removing slops, rain water, and soil water.

5. The limits of application of the earth system in the future cannot be stated. In existing towns, favorably arranged for access to the closets, the system might at once be applied to populations of 10,000 persons.

6. As compared with the water-closet, the earth-closet has these advantages: It is cheaper in original cost; it requires less repair; it is not damaged by improper substances being thrown into it, and it very greatly reduces the quantity of water required by each household.

7. As regards the application of excrement to the land, the advantages of the earth system are these: The whole agricultural value of the excrement is retained; the resulting manure is in a state in which it can be kept, carried about, and applied to crops with facility; there is no need of restricting its use to any particular area, nor for using it at times when, agriculturally, it is worthless; and it can be applied with advantage to a very great variety, if not to all, crops and soils.

Prof. A. B. Palmer, of the Medical Department of Michigan University, states the advantages of the earth closet as follows:

1. A comfortable closet *on any floor of the house*, which may be supplied with earth and cleansed of its deposits without any annoyance or inconvenience.

2. A portable commode in *dressing-room, bed-room, or closet*, the care of which is no more disagreeable than that of a stove.

3. A convenience for the use of invalids, which greatly facilitates nursing.

4. The removal of the most fertile source of typhoid fever and various other diseases.

5. The complete suppression of the odors which, despite the comfort and elegance of modern living, still hang about our cesspools and privy vaults, and attend the removal of their contents.

6. The complete deodorization of the bucket commonly used in jails and prisons.

7. The utilization, under favorable circumstances, of a fertilizer of material value.

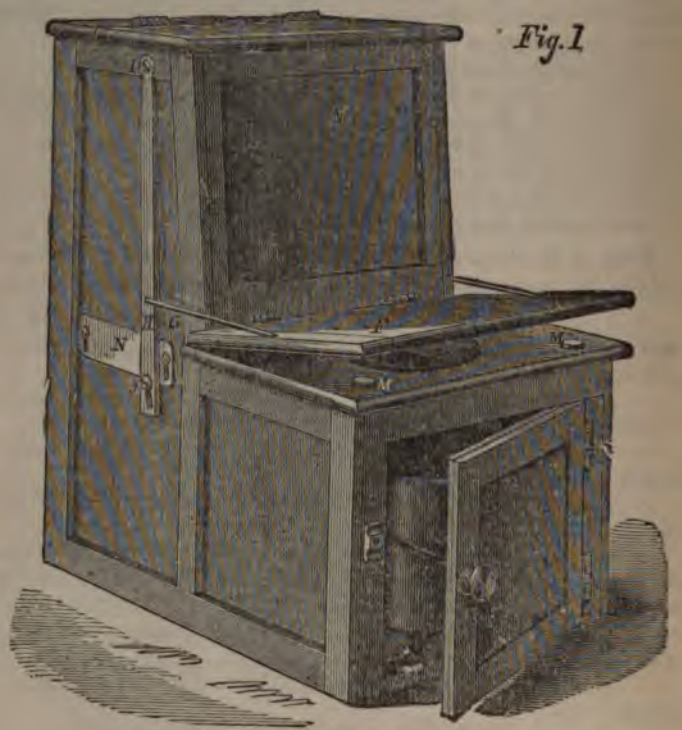
Mr. Talman, of Concord, Mass., who has used the earth-closet, says:

We have never experienced any unpleasant odor, either from the closet itself, or from the earth which had passed through it. The latter has been kept in open barrels, standing in my cellar, side by side with barrels containing earth sifted ready for use; and as I have taken the precaution to cover the earth which has been used with an inch or two of fresh earth, it is impossible to tell which dirt has passed through the closet and which has not, except by marking the barrels, so thorough an absorb-

☞ PLEASE PRESERVE FOR REFERENCE

THE WAKEFIELD EARTH CLOSET.

Fig. 1



Wakefield Earth-Closet.

The illustration on the opposite page shows the working of the best known and the most satisfactory style of earth-closet. *L* is a large galvanized iron pail; *A* is a reservoir filled with earth, and with a valve at *B*; *C* is a sliding pan with a bottom of slats, *K*. When the cover or lid, *F*, is raised, the pan slides back and is filled with earth. When the lid is shut down, the pan slides forward to the position shown in the sectional engraving, and the slats, *K*, open, depositing the panful of earth *evenly in the pail below*. That is the whole of it. The raising and shutting down of the lid work the earth-valve, sliding pan and slats. The reservoir needs to be filled when empty, viz: after using 150 times, and the pail requires to be emptied only when full, say once a week. Nothing could more perfectly answer the purpose. It gives out no odor; is not ill-looking; its usefulness is not limitedby any defect what ever. Besides the essential parts above described, there is a sliding seat for children, which is drawn into position by the knob on the left; also, a dust-screen slide worked by the knob on the right, a decidedly useful appendage.

[The electro-types were kindly furnished by the Wakefield Earth-Closet Company, of New York.]

SKELETON CUTS

SHOWING THE MECHANISM OF THE

WAKEFIELD EARTH CLOSET.

Fig. 2

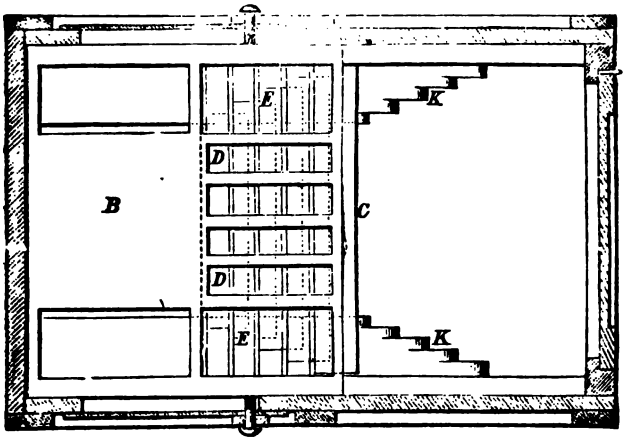
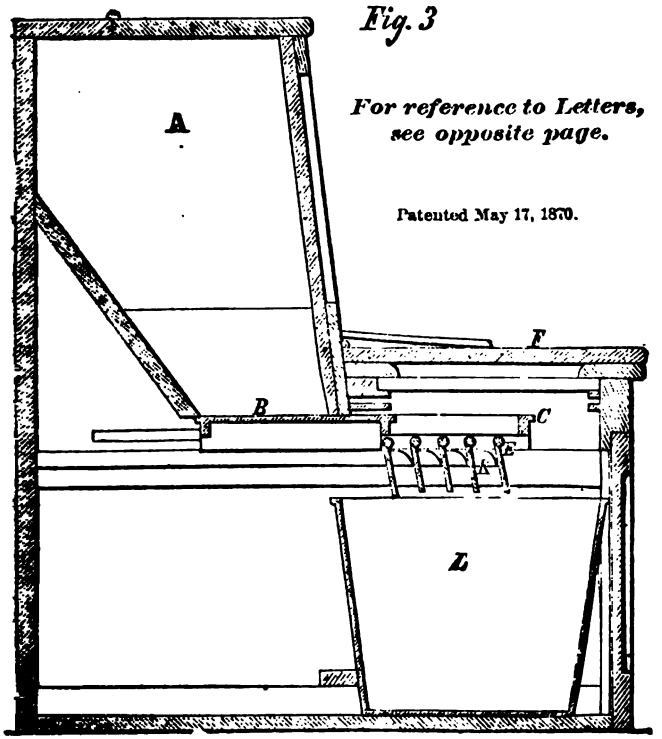


Fig. 3



For reference to Letters, see opposite page.

Patented May 17, 1870.

ant and deodorizer does the fine soil prove. As one result of the use of the closet, I had in the spring ten barrels of earth, filled with fertilizing matter, as fine as any of the phosphates of commerce, and of great value for use in my garden.

THE PAIL SYSTEM.

This system, all things being considered, is the best one for all portions of the city. Dr. T. S. Verdi, of Washington city, D. C., was in 1873 sent by the Governor of the District of Columbia, a special sanitary commissioner to visit the principal cities of Europe. Dr. Verdi, in his report, says:

"I must express my unqualified opinion, that, after my inspections in London, Liverpool, Manchester, Brussels, Lyons, Marseilles, Paris, Turin, Milan, Mantu, and Verona, and other places in Europe as well as in America, the Rochdale (pail) system is the best."

THE SYSTEM.

The "pail system," as conducted by the city authorities of Rochdale, Dr. Verdi describes as follows:

The closets are made, or so arranged, that either at the back or at one side, a shutter is raised to allow the admittance or removal of a tub under the seat. The tubs are made from disused paraffine casks, cut in two by transverse section. * * Iron handles are attached to the tubs, and a rim is adapted to the inside of the tub to accommodate a close-fitting cover. Before removing the tub the cover is put on." * * "The pails in use are removed once a week, and replaced by clean ones, supplied with sufficient liquid disinfectant to prevent the fermentation and decomposition of matter for another week. * * The removal of the tubs is done by the scavenger during the working hours of the day, and the neatness and the cleanliness and facility of the system is such that no nuisance whatever is created, and no foul smell permitted to escape. During my inspection at Rochdale, the resident citizens assured me that though the exchange is often done through their houses, no smell at all is left behind to make them conscious of the operation. The garbage and ashes are thrown together in similar tubs or barrels, no liquid matter being allowed therein. * * These collections are all taken to the same sanitary depot.

The Board of Health of Massachusetts, referring to the system, says:

"The process of removal is quite inoffensive, *and is systematically performed.* The population of Rochdale* in 1871 was 67,754; inhabited houses, 13,938, of which 2,944 were fitted with 'pail-closets,' used by 11,770 persons. In 1874 the number of houses so fitted was 7,287, used by 43,500 persons."

* Rochdale, in 1867, before the introduction of the pail system, had 4,000 Midden closets and 300 water-closets. It was, therefore, to some extent, a sewered town. Yet, notwithstanding this, the water-carriage system was abandoned and the pail system adopted in 1870.

This population is larger than that of Atlanta.

"Mr. Radcliffe reported essentially as follows: That the system of removal had been thoroughly approved by all who had had experience of it: and that it had not failed under the most varied circumstances, having proved equally efficacious in the highly rented house with its own closet, in the lodging house where great numbers were accommodated, and in the factory and workshop."

Dr. Lecardre, of Havre, after careful study, arrives at the conclusion that the tub (or pail) system will give the best sanitary results, besides contributing to the claims of agriculture.

In 1870, a commission was appointed in Heidelberg on cleansing and draining that city. The report was prepared by Dr. Mittermaier. The commission, among other things, recommended the disposal of filth by a pail system. This was carried into execution, and in a pamphlet written by Dr. Mittermaier, in 1875, he gives a glowing account of the workings of the system in that city.

The system differs in some of its details from that in operation at Rochdale. The pails in Heidelberg are made of strong sheet-iron, and are firmly connected with a soil pipe, a siphon trap being interposed at the point of juncture. Pails thus made last a long time; those in Heidelberg having been in use six years.

Dr. J. Wyatt Crane, Health Officer of Lancaster, (England) writes under date of Feb. 11, 1876:

"Our sewers still discharge their contents into the river, but we are striving to diminish the amount of fecal matter as much as possible. We have adopted for this purpose the system which originated in Rochdale, and which is called the pail system, and consists of a galvanized pail placed under the seat, which is removed once or twice a week, in a vehicle constructed for the purpose and conveyed to the depot, where it finds customers among the neighboring farmers, and I need not say, *is an excellent manure.*"

IS THE SYSTEM PRACTICAL?

This is a question that will be asked by our people. They will wish also to know if it can be made available in Atlanta. Dr. Mittermaier, in the account referred to, remarks:

"Every one who has seen the system in actual working has always expressed complete satisfaction therewith, so far as our experience goes. Indeed the advantages of the system must be evident to every unprejudiced observer. In houses supplied with pails which were formerly subject to the most unpleasant smells issuing from the privy-pit or the drains (sewers) the inhabitants at present enjoy pure air, and the assurance that

their health will no longer be injured by these hurtful emanations which were formerly given off from the moist and saturated brickwork of the privy-pit. * * * As the inconveniences of the pail system have been much insisted upon by its opponents, we may here emphatically remark that their fears have proved quite groundless. The changing of the pails, especially here in Heidelberg, is accomplished without any disturbance of the household, and can be made at any time of the day. * * * When once a beginning is made, the community will soon be convinced that the management of the pail-system is by no means so difficult as at first imagined. They will see that the pail-system for the inhabitants of a place and for the well-being of the people, is attended with the greatest advantages. This system is for the public good, and therefore deserves to be taken in hand by the community. * * * The repute of this system is not confined to this city and its neighborhood, *but it has been adopted in* 41 *other places;* and in these also its use is not confined to private houses, but has extended to schools, hospitals, and noblemen's seats. From every side we receive most favorable reports and expressions of satisfaction, and the application for further supply from the makers here continues to increase. Nurnberg has recently rendered the adoption of the pail-system according to our pattern compulsory."*

Dr. Verdi, in his report, says:

"After many trials and experiments in the cities of Europe, to relieve the people from poisonous exhalations from accumulations of human excreta and garbage, and from the inconvenience from the collection of ashes, without incurring a serious expense in the removal of the same, the pail-system was adopted by the corporation of Rochdale. After three years trial it has proven the most efficient in removing the nuisance, the safest in a sanitary point of view, the simplest in its application and the cheapest in the manipulation of it. Nay, it has solved the difficult problem and proven that garbage, night-soil and ashes are such valuable materials as to be a source of revenue instead of expense to a city."†

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* Maj. Gen. Cotton, referring to the water-carrage system, remarks: "Water in certain quantities *aids in the decomposition of our refuse and supplies some of the ingredients* of the noxious gases that we dread. Great efforts have therefore been made to avoid the use of water and so called *dry-systems* have been introduced and tried, in some localities WITH SUCCESS; but I need not enumerate them." * * "We may however, wish their promoters God-speed, while we *make the best of the means (water-carriage) now at our disposal,* which must, under any circumstances be in use for many years to come, *even though any safer system should eventually be perfected.*" This applies to cities having water-closets and complete sewerage. Atlanta should not rush head long into extravagant sanitary schemes, which must be abandoned in the end, when safe measures can be easily and successfully carried out.

† Dr. Edwin M. Snow, Superintendent of Health, of Providence, R. I..

SANITARY ADVANTAGES.

The sanitary advantages of the system are apparent from what has already been said. Dr. Verdi asserts that those distinguished Sanitarians of England, Messrs. Simon, Buchanan, and Radcliffe, (all of whom have been appointed on Royal Commissions and members of the Privy Council) assure him, that it was the most successful, in a sanitary point of view, and the most economical system known in England. And it was through their advice and recommendation that he visited Rochdale. The mortuary statistics show that under the operation of the system the death-rate has been very considerably lessened—the death-rate of Rochdale being now 21.19 per thousand persons, while the healthiest sewered cities of England are not less than 22 to 23.

The Massachusetts State Board of Health remarks:

"As to the working of the pail-system. The moveableness of the pails is their great recommendation—the facility which the system gives for frequent, thorough removal being enormous. In this connection, it is impossible not to be struck with the advantages that a pail-system has, in relation to diseased excrement. The facility and thoroughness with which any required chemical disinfection can be done, and the way in which the excrement, itself, can be wholly got rid of, leaving none of its

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and late President of the Public Health Association, in a letter to the writer, after referring to the methods of removing fecal matter, says:

"We have since, at my suggestions, got up a method of removing night-soil which is effectual, very economical, and with so little nuisance that we permit them to operate at all times, in the warmest weather. Or rather we compel them to do the work in the day time in special cases. Instead of carts or boxes, they use tubs. Each tub is made strong, largest at the bottom, with strong iron handles and with covers rimmed with rubber and made so as to be screwed down absolutely air and water tight. These tubs are taken into the yard by the side of the vault, and provided with a rubber apron leading from the top of the tub to the vault. Iron dippers (only) are used. The tub is filled, the cover put on and screwed down, the tub washed off clean, and is then carried to the street and put on to the cart or wagon. Of course there is no possible nuisance to the sight or smell, except at the vault, and that is slight. In warm weather we oblige them to disinfect the night-soil before removal. The tubs are carried through the streets with perfect freedom, and are sent off on the cars sometimes and the contents sold. Each tub holds 24 gallons; 12 tubs make a load for two horses, of about 38 cubic feet."

This, as seen, is a combination of the vault and pail-system and fairly illustrates the advantages of the tub or pail system even with the disadvantages of the vault system added to it.

products behind—nothing soaking into the ground, or hanging about midden-pits, or sewers, obviously suggest most important powers possessed by this system for preventing the spread of excremental diseases."

This is a most important fact, as it is here clearly asserted that soil contamination, and excremental diseases are less liable to occur under the workings of the pail-system than that of water-carriage. In corrobaration of this, the following interesting statement is made by Dr. Littlejohn, Medical Officer of Health for Edinburgh:

"Edinburgh consists of two distinct towns, an old and a new, but with very different populations. The new town is inhabited by the better classes, and is pre-eminently a water-closet town; whereas, the old town consists, for the most part, of over-crowded tenements, in which pails are used for the reception of excreta. These pails are brought to the streets daily, and emptied into carts provided by the authorities. Considering the low morality of the population, the bad ventilation, the overcrowding and the retention of the filth in the living-rooms for the greater part of the day, it might naturally have been supposed that typhoid and diphtheria, would be endemic in the old town. This is not the case, however, for, despite the surrounding conditions, these diseases may be said to be practically unknown. But in the new and water-closet town the case is quite different; typhoid and diphtheria are never entirely absent, are frequently epidemic, and it has been noticed that the ravages of these diseases have been greatest in the best houses."*

The Rockdale system is, as shown, a decided improvement over the tub system used at Edinburgh, and by far superior in a sanitary view. The contrast will, therefore, be further heightened by the consideration of this fact.

Dr. John Simon remarks:

"The choice between a water-closet system and a system of so-called dry privies (pails, etc.) is, necessarily, in each case, a question for *local judgment*, on grounds which, in great part, must be purely local."

As before stated, Dr. Simon is an advocate of water-closets, under the necessary conditions.

Dr. Mittermaier in reference to Heidelberg, says:

* The City Engineer, in his annual report, of 1876, remarks: "It has been shown, beyond controversy, that sewer-gas in houses can be successfully avoided, by well known principles of sanitary engineering." It will appear, however, that notwithstanding the application of these "principles of sanitary engineering," in the new portion of Edinburgh sewer gas does gain admittance into the houses. In another part of this report, the fact is demonstrated "beyond controversy," that the city of Corydon, England, so approvingly referred to by the City Engineer, suffered for fifteen months, last year, from a terrible epidemic of typhoid fever, caused by sewer gas escaping in houses.

"By the aid of the pail system we have been enabled to remove many sanitary imperfections of the worst kind. * * In the war years 1870 and 1871, the pail system was particularly successful, and prevented the seeds of disease being spread elsewhere. This was especially the case in the so-named epidemic barracks, where those soldiers suffering badly from typhoid or dysentery were placed."

ADVANTAGES OF THE SYSTEM.

As given by Dr. Verdi, the advantages of the system are as follows:

The night-soil is removed once a week, and is kept disinfected instead of being allowed to exhale fetid gases in boxes for two or three months before its removal. It would save the city many thousands of dollars per annum, without making a fertilizer. Not one cent need be charged to the citizens for the removal of night-soil, garbage and ashes, and if the corporation prefers not to make the fertilizer, it needs only a tax sufficient to pay for the removal of those three nuisances. It is a neat, effective mode of removing those three nuisances without creating a new one. It is easily done and easily controlled. It is comprehensive and effective. It is done in day time instead of at night, without offense to delicacy and to the salubrity of the air. The manure is an excellent article, and by selling it at the low figure of $10 per ton, it would more than cover all expenses for the removal of garbage, ashes, and night-soil and the manufacturing of the fertilizer."

The conclusions reached by Dr. Mittermaier are:

1. A well managed pail system, as that of Heidelberg, satisfies every sanitary and technical requirement. After a perfectly unprejudiced comparison, it may be declared as equal to the best systems, and it possesses indisputably certain advantages peculiar to itself.

2. Such a system can be easily introduced and carried out under the greatest variety of circumstances, both in cities and villages. The cost of working it can, under proper management, be covered by the receipts; perhaps, even, under favorable local circumstances, the undertaking can be worked at a profit.

3. This system, also, at the same time satifies the well deserved claims of agriculture.

COST OF THE SYSTEM.

This appears from what has already been said, but a few additional facts may not be amiss. *It is the most economical system.* Dr. Mittermaier says:

"The expenses in the current year were 5,530 marks ($276 10s): income, 5,500 marks (£275), so that the cost of working the system is covered by the income." "The records of the Financial Committee of the Council (of Rochdale) show," says Dr. Verdi, "that all expense attending the workings of the system have been paid from the sale of the material removed thereby, and promises an income when generally adopted." * *

"The fertilizer obtained from this process, which, although considered worth $10 a ton in England, is sold for $5; and at this low rate pays for all expenses of collection and removal of night-soil, garbage and ashes,* as well as the manufacture of the fertilizer derived therefrom. * * This proves that in a financial point of view the pail system is the only one from which sufficient revenue is derived to pay cost of removal."

The cost of the system to the citizens would be less than any other, as privies could be converted into pail-closets. The pails, as shown, cost very little. The cost of water-closets to the citizens would be a considerable sum at the outset, and the constant repairs necessary to keep them in good working order (and under supervision of the city authorities), would annually amount to more than the original cost of pail-closets. Dr. Buchanan—after personal observation of the system in London—asserts that the water-closet is a "delicate machine," requiring constant attention, and the Massachusetts Board of Health emphatically states that the system is "too costly for universal application."

In many of the cities of Europe the annual profits arising from the sale of excrement are largely in excess of the cost of removal. In Atlanta, Mr. Lambert pays $100 annually for the use of the fæcal matters of the U. S. Barracks; and Mr. De-Give, of this commission, employs the pail system successfully, applying the excreta obtained this way in the city to the improvement of his lands.

CLAIMS OF AGRICULTURE.

It has been clearly demonstrated by the testimony of the very highest sanitary authorities of England that the water-carriage system can never be made to return to the soil any considerable portions of the valuable fertilizing properties of fluid and solid excreta, and the only plans for doing so must be through the various conservative systems.

Prof. Leibig, the late distinguished German chemist, when contemplating the enormous waste of this valuable material, remarks:

"The coming generation will consider those men as the greatest benefactors of mankind who devote all their efforts to utilize and save the night-soil of cities."

* It will be seen from this statement that the expenses of the scavenger force—a necessity under any system—are included in this estimate; hence the cost of the removal of the excremental matters alone will be much less than that given by Dr. Verdi.

The soil furnishes man and beast with food. The food of man and all animals contains mineral matters taken from the soil, and all appear in the excreta. Recent fæcal matter contains an average of 25 per cent. of solids and 75 of water. Of these solids, phosphoric acid constitutes fully one-third. A city numbering the population of Atlanta, would yield nearly 500 tons of dried fæces annually, containing little less than 40,000 pounds of phosphoric acid.

The editor of the "Scientific American," speaking of the recent efforts being made in Europe for utilizing the refuse of cities, predicts the practical adoption of some method as a question of time only—"which by the growth of the country must be eventually forced upon us."

The dry-earth system has been tested for this purpose. Dr. Buchanan remarks:

"The cost of working the system has been carefully computed, and in a village of a thousand people would be £260 a year, and the value of the manure (say 720 tons at 10s. per ton) would be £360, supposing that the earth had been used only once; but if employed four times over, the annual outlay would be reduced to £244, and the product, amounting to 200 tons a year, would, at £3 a ton (the price at Dorchester, and the estimated value of it by Mr. James, the agent of Baron Rothchilds), realize £600 a year. Even at the approximate value of 10s. per head of the population, it would be worth £500, and this would be a profitable return, helping to pay the cost of other sanitary work."

The practicability of manufacturing a fertilizer from excrement, notwithstanding its denial, is a well established fact.*

Refuse taken from vaults in the city of Newark, N. J., is being made into a fertilizer, and at Rochdale the excreta has been for several years manufactured for the same purpose. A discription of the process employed at Rochdale may not be uninteresting. The refuse is taken to a sanitary depot. "This depot need not be in a remote portion from the city, as it creates" says Dr. Verdi "no nuisance in its operations. A shed 200x120 is sufficient; a little room for the office is divided off; a set of scales are placed in front of the office. Every load of excreta or ashes that arrives is weighed and its weight en-

*Proudrette made at Paris and some other places is the product of dried fæces. The urine which is the most valuable constituent as a fertilizer is lost. Hence, proudrette is not as valuable a fertilizer as that made at Rochdale, where all the urine is preserved.

tered in a book. The ashes and garbage are dumped from the cart on a drying floor, and when dry are poured through a riddling machine worked by steam power. * * * The fecal matter upon its arrival, is emptied into a trench formed by a banking of ash, covered and mixed with it. The ash acts as a catalytic, refraining decomposition and retaining the gases. While in the trench the contents are treated with sulphuric acid. After this treatment the matter is allowed to stand three weeks, stirring and turning it once each week or oftener, if thought necessary, to prevent charring. At the end of that time the mass has become a dry powdery manure, free from smell and ready for the market. The strength of the manure can be doubly increased by exposing it again to another treatment of fecal matter and sulphuric acid as before. The manure is essentially of excellent character, as it contains all the elements of fecal matter, of urine, of the ashes, of the vegetable and animal matter and house offal. The tubs, immediately after being emptied are thoroughly cleaned by subjecting them to a powerful stream from a hose at hand, then supplied with the disinfectant, and sent out to exchange for full ones."

Another important improvement in the manufacture of fertilizers, the discovery of which, says a distinguished writer, affords for many cases a practical solution of the difficulty of disposing of excrement, has just been announced in Great Britain, having reference to a substance called Huano manure. This material it is claimed, is as rich as Peruvian guano, and its manufacturers furnish a guarantee to that effect. It is worth, according to the scale of fertilizers, from $40 to $45 per ton, although the cost as manufactured, is less than $13 per ton. In the course of inquiries leading to the invention, it was ascertained that Portland cement transforms night soil into stone, which upon being crushed gives 18 per cent of phosphate of lime, and when applied as manure to growing turnips, it has produced 20 tons to the acre. Owing to the insoluble nature of the phosphates, however, the action was slow and the next step in the process was to utilize this property of cementation in the superphospate manufacture in which night soil is substituted for water in the decomposition of the phosphates. During this process the phosphates part with the two

portions of their lime, uniting with sulphuric acid to form sulphate of lime (plaster of Paris,) from which is derived the valuable property of cementing night soil from a liquid into a solid mass. This solidification produces simultaneous deodorization, removing all offensive and foul effluvia, as well as any capability of giving out deleterious gases, and such powers of destruction are transformed into fertilizing endowments. It will thus be seen that cementation lawfully usurps the place hitherto occupied by fermentation and evaporation and hydrates all the moisture—which, being chiefly urine, possesses manurial value to the last drop—together with the incorporation of the whole of the ammonia, alkaline salts and other valuable constituents consisting in the night soil.

The advantages of this fertilizer are these:

1. The night soil gives that pasty condition to phosphates essential to the reception and dilution of the acid employed in superphosphate manufacture.

2. The phosphates are increased one-fourth in quantity from the alkaline phosphates and phosphoric acid of the soil; thus if 75 units of phosphate lime are introduced 100 are withdrawn.

3. The phosphates receive a new supply of nitrogen equal to from two to four per cent. of amount from the soil.

4. The phosphates obtain five to eight per cent. of alkaline salts containing one per cent. each of magnesia and potash from the soil.

6. The phosphates receive in addition 16 per cent. of organic matter intermixed with the urea and uric acid, possessing the latent quality of evolving ammonia to the last atom, and inducing nitrification as well as the ammonia and nitrates as returned in the analysis.

On the other hand night soil secures from phosphates the following advantages: cementation, solidification, deodorization, portability by rail or sea in the service of agriculture; the bringing within the pale of sanitay laws, contributing to health, and municipal revenues. It is even suggested that the present superphosphate manufacture must ultimately pass over into night soil utilization either voluntarily or by legislative enactment.

Other processes are capable of effecting conversion of ex-

crement into a fertilizing product. Rev. Mr. Logan, in a communication to the Commission, states he has a processs he has thoroughly tested. The fact then that excretal matters can be successfully manufactured into a valuable fertilizer is fully established. In many places in Europe the fecal matter is conveyed directly to the fields and applied to the soil, being buried at once, when it becomes disintegrated and deodorized, giving fertility to the soil so treated.

Dr. Daniel Lee, who ranks among the ablest agricultural writers of this country, referring to the employment of excremental matters as fertilizers, remarks:

"Why have savage tribes resisted for unknown ages the great law of human evolution? For the same reason that the inhabitants of all American cities resist all efforts to break up the filthy hot-beds for propagating diphtheria, scarlet-fever, pneumonia, typhoid fever, and a score of other fatal maladies. As savages cling, with all possible tenacity to the dead past, so do others, a little more humanized, cling to the *cloacæ* of ancient Rome. The Romans did not have our knowledge of pure air, water, and all proper human food; did not know the value of city fertilizers."

"It was not discreditable in them to construct costly sewers to send into the Tiber the elements of all crops which tilled earth needs to yield remunerative harvests. After, or before it, comes the serious want of manure; and it is at this point that our mental evolution fails to move a peg; that our plowing becomes a scourge instead of a blessing to ourselves and our posterity. Why not give up the Roman and Grecian practice of propagating pestilence in cities, and let all human excrements be at once deodorized, thoroughly dried, and sent into the country to fertilize the soil? Agriculture, horticulture, and all substantial progress in wealth, population and morals, demand this step forward, beyond our present sickly position in cities, and beyond the age of impoverished fields and poorly rewarded farmers. Common sense and evolution call loudly and continuously for the general use of concentrated fertilizers to increase the fruitfulness of all tilled ground as fast as population increases. Why should our mother earth be made less and less productive from one decade to another, while the human family may double its numbers to be fed and clothed every fifty years?"

DISPOSAL OF GARBAGE AND LIQUID FILTH.

It is quite evident that garbage, such as dead animals, bones, ashes, street refuse, etc., cannot be removed by water-carriage. These must be disposed of. For this purpose, a scavenger force is absolutely necessary. The streets must be kept clean, no less than the yards and premises of our citizens, and a well organized scavenger force alone can do this duty. All kinds of garbage must be carted away under any system,

and it has been shown that these matters can be utilized in the manufacture of a fertilizer.

The cost of a scavenger force to the city—a force competent, also, of removing the excrement, by the pail system—is shown in the official paper from the authorities of Paris to Mr. DeGive, of this Commission.

Liquid filth must be disposed of. It has been asked: Suppose the various systems of conservancy are adopted, what disposition will be made of the liquid filth? If our city must have drains, or sewers, for carrying away the liquid filth, why not use them for removing the excreta of the population, also? especially, as the analyses of streams, in England, show that those into which the liquid filth is poured, contain nearly as great a quantity of excretal matter as those into which are discharged the contents of water-closets?

To these questions answers become necessary. If the analyses of English streams show the result above stated, then it is evident that: 1. If the pollution of the five rivulets emerging from Atlanta—the danger of which to health has been shown, and admitted by every member of the Commission—should be considered of no importance, then all the refuse of the city, including fæces and urine may be poured into them; or, that, 2. The pollution of these runlets being granted, *none of these* should find entrance into them.

It will be seen, therefore, that the question proposed, as an argument, proves too much. It assumes that the liquid filth of a town is as dangerous to human life, when poured into a stream, as the fæces and urine of the population added to it. If this be true, then, Atlanta being under consideration, the united voice of Sanitarians must stand arrayed against it, as has already been demonstrated. This has especially been shown to be the fact in respect to the action of the "International Medical Congress." In regard to "sewage" the Congress asserted:

"Conditions sufficient for sanitary security are afforded by the discharge of sewage, at a considerable distance from a town, into the sea, or into a large and rapid river, whose water, at least for many miles below the exit of the sewers, is not used for drinking."

Dr. John Simon says:

"The obligation not to cause nuisance by sewage outfalls exists in an infinite range of magnitudes, from the vast sewage tunnels of London, on

the one hand, to the little village sewer and its occasional flushings, on the other; but whether as to village slop-waters or to great urban sewage floods, equally it has to be provided that no avoidable atmospheric nuisance shall be produced by the outfall, and that all natural water-courses * * * shall be protected, as far as practical, from pollution."

"If existing slop-water sewers are offensive or inefficient in the service in which they already act, or if their outfall is such as already to cause nuisance, or water pollution, evidently no such additional service as the conveyance of privy sewage can be claimed of them in their actual state: but in this class of cases (and according to the degree of offense or inefficiency) the local sewerage would be judged to require reform, even apart from any question of water-closets."

If, then, the analyses of English streams be correct, and the sanitary law, as given by the Congress, and Dr. Simon, be true, all sewage, whether simply liquid filth, or containing, besides, the fæces and urine of the population, should be excluded from the five rivulets emerging from Atlanta.

The statement is made by the English River Pollution Commission, but is incorrect. Yet, if correct, would not apply to Atlanta, as our city is not a midden-town. The English Commission had reference to streams upon which midden-towns were located.

Dr. Letheby, the late able chemist and Public Health Officer of London, says:

"But, although a large quantity of excrement is thus collected (in midden-pits) in the chief towns of Lancashire, and, therefore diverted from the rivers and water courses of the district, yet according to the Rivers Pollution Commissioners, it has had no appreciable effect on the condition of the outfall streams. They say, in fact, that the sewage of Machester, Liverpool, Salford, Macclesfield, Bolton, and other midden-towns of Lancashire, is but little better than that of places where all the excreta are discharged into the sewers,* and, in illustration of this, they give the chemical composition of thirty-seven samples of sewage, from fifteen midden-towns, etc., and of fifty samples of sewage from seventeen places where water-closets are used, and the following are the maximum, minimum and average results per imperial gallon:

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*It has also been asserted, in the progress of the discussion by the Commission, that sewage composed exclusively of soiled waters, slops, etc., contained almost as great a quantity of organic decomposable matter as when the excrement of the population was added.

Over fifty analyses of London sewage which were made for the purpose of determining the amount of organic matter in pounds, to every 1,000 persons, show that the sewage contained 108 pounds of excretal organic matter, and 68 pounds of organic matter from other sources; thus proving the error embodied in the statement referred to.

Constituents per Gallon.		Maximum.	Minimum.	Average.
		Grains.	Grains.	Grains.
Sewage of Midden Towns.	Matters in Solution	293.72	21.77	57.68
	Organic and other Nitrogen	9.17	1.11	4.52
	Chlorine	15.05	4.55	8.08
	Matters in Suspension	92 26	6.02	27 38
	Organic	36.48	3.12	14 91
	Mineral	55.78	2.90	13.47
Sewage of Water-Closet Towns.	Matters in Solution	82.46	28.84	50.54
	Organic and other Nitrogen	17 03	1.66	5 41
	Chlorine	15.05	3.01	7.46
	Matters in Suspension	163 91	3.46	31.29
	Organic	35.95	2.87	14.36
	Mineral	127.96	0.59	16.93

"From which it would seem that although the average amount of suspended matter in the midden sewage is a little less than that of water-closet sewage (in the proportion of 27.38 grains to 31.29) yet the dissolved matters are actually more (in the proportion of 57.68 to 50.54:) and notwithstanding that the quantity of sewage from a water-closet town is considerably larger than that from a midden town, yet, judging from the proportion of chlorine in the two cases, representing, as it generally does, the quantity of common salt in the urine, the Commissioners conclude that, for equal volumes of sewage, there have been 1,154 persons contributing to it, in the case of the midden towns, and 1,064 in the other. The inconsistency of these conclusions is demonstrated by the very facts which the Commissioners have themselves published as to the quantity of night soil collected annually and sold for manure in the several midden towns alluded to. All of which is so much matter kept out of the sewers. It ranges from 1,200 tons a year at Clithero, with a population of 7,000 persons, to 138,777 tons at Liverpool, with a population of 500,676—the average amount at 16 places with an average population at each place of 83,785 persons, being 25,561 tons per annum: *which is more than six times the total quantity of suspended matters in the entire sewage of the several places*, supposing them to have been water-closet towns, yielding an average of 60 gallons of sewage per head per diem, and that the sewage contained 31.29 grains (the Commissioners' proportion) of suspended matters per gallon. It is hardly possible to imagine a more extravagant illustration of the way in which opinions created by an impulsive bias may be made to over-ride the actual facts of an inquiry."

The question would also seem to imply that human excrement is not more dangerous to life than other organic matter contained in sewage. All sanitarians know that excretal matters contain the germs of zymotic diseases—those diseases

which prevail as epidemics. The Massachusetts Board of Health, says:

"Of all forms of filth, the *most dangerous*, as well as the most offensive and most common, is *fecal excrement.*"

In the 12th Report of the Privy Council, Drs. Buchanan and Radcliffe, say:

"The propagation of certain epidemic diseases, especially cholera, enteric (typhoid) fever and diarrhœa, among communities, as the result of excremental pollution of air and water, is one of the best established facts of sanitary medicine."

Dr. John Simon, head of the Medical Department of the Privy Council, in the same report, remarks:

"The circumstances which alone enable typhoid fever and most other diarrhœal infections to become epidemic or endemic, are well known "to the educated parts of the public. The experience of 1869, substantially uniform with one another, and equally in accord with previous observations, repeat again and again the general lesson, that infections here mentioned denote excremental poisoning," From this cause "the inhabitants of this country are sustaining damage year after year to a really appalling extent. The deaths are but a part of the mischief—for that needless warfare against human life has its wounded as well as its killed—yet even the deaths are in myriads. The 15 to 18,000 deaths by typhoid fever which annually occur in England, are essentially due to such conditions; on such equally depends the power of imported cholera to become epidemic among us; and of the 15 to 30,000 deaths per annum which are registered as due to our ordinary diarhœal diseases, a very large proportion are undoubtedly of the same source. Moreover though, beyond this point, the admixture of causes is too intricate for equally exact proofs to be possible, it is not for a moment to be supposed that the above described terrible causation of fatal bowel infections is the only mode in which excremental mismanagement affects the public health. Of the mortality of young children, not referred to bowel infections, probably a very large share (much of it registered as "convulsions") is due to excremental poisoning; and it seems highly probable that many zymotic diseases, besides those I have mentioned, find in similar circumstances their amplest opportunities for mischief." "It has long been among the most fixed of the certainties which have relation to civilized life that, wherever human population resides, the population cannot possibly be healthy, cannot possibly escape recurrent pestilential diseases unless the inhabited area be made subject to such skillful arrangements as shall keep it habitually free from the excrements of the population."

Dr. Radcliffe, in his report of the epidemic of typhoid fever at Ashton, says it was due to "accumulation of *excrement.*" Referring to Tottenham, he speaks of a serious outbreak of

typhoid fever, with high rate of mortality caused by contaminated water supply with decaying animal refuse contained in the water courses and ditches, and from large deposits of sewage mud at sewage works.

Dr. Corfield in his report of the epidemics of scarlet fever, measles and typhoid fever at Biggleswade, attributes the outbreak and spread of these diseases to "general pollution of earth, air and water by *excrement*."

Dr. Buchanan, in various reports, refers to this source of poisoning. At St. Just, scarlet fever was very fatal, and typhoid fever was habitually present. Almost universal foulness of soil and air existed with want of provision for *excrement* removal.

At Sheerness, typhoid fever was prevalent from "universal accumulation of *excrement*."

At Whitehaven, a severe epidemic of true typhus occured. Typhoid fever was "constant," and there was "wide-spread fouling of earth and air with *excremental* filth."

Dr. Harris, in his report of Wooksop Union, speaks of "frequent prevalence of fevers and diphtheria," with "almost everywhere want of proper water supply, and due to *excrement* removal."

Dr. Wagstaffe reports at Wycombe, "high mortality from scarlatina and other fevers." The "water supply scanty and largely contaminated by *excrement*."

Dr. Thorn reports epidemic of typhoid fever at Appledore, where the "*excrement*" had been suffered to accumulate.

Dr. Simon says, where epidemics of typhoid fever, cholera or diarrhœa occur, they have been traced to "some gross *excremental pollution of air or water*."

It has also been shown that many English towns having sewers will not employ them to transport excremental matter. Therefore, taking the sanitary law as given by the International Medical Congress, coupled with the facts above stated, it will be seen that if Atlanta had sewers excremental matters should be excluded from them.

How should Atlanta dispose of its liquid filth? For convenience, this filth may be divided into three classes:

1. The urine.

2. The fouled waters—used in washing, in bathing, from manufacturing, etc.

3. The kitchen slops.

Under the pail system, the urine is more effectually disposed of than even the water-closet system, for there is less pollution of the soil by the former than the latter system. This has already been shown, when speaking of the pail system. In every privy, having pails, urinals should be placed to convey the urine to the tubs, in order to catch and save it. It contains the most valuable constituent elements and compounds entering into the composition of a good fertilizer, and should not be wasted.

The fouled waters should be disposed of in two ways:

1. In the central portions of the city, they should be conveyed away by the pipe system. The organic matters contained in them will not seriously pollute the rivulets. The waters from manufacturing establishments must also be carried off by the same means—all other refuse from them being conveyed away by the scavenger force.

2. In the other portions of the city, these waters should be applied to vegetable and flower gardens. They contain alkalies in solution and are of considerable value as fertilizers.* Scattered over gardens and absorbed by the rootlets of plants, they are rendered harmless as producers of disease, and give increased productiveness to garden soil. This should be done at all seasons of the year.

The kitchen slops contain considerable quantities of organic matter. They should be excluded, if possible, from entering the earth pipes:

1. Because they contain matters which a wise economy demands should be utilized.

2. Because these organic matters—from the kitchens of 40,000 persons—will pollute the rivulets flowing from our city; *i. e.*, if Atlanta is sewered for this purpose.

* The *Scientific American* asks and answers the following question: "Who would throw away a barrel full of soft soap, or a box of hard soap? Were it not otherwise useful, it would be of great value as a fertilizer, if spread, in its raw state, about our fruit trees or berry bushes. But, after being dissolved in water and passing through the wash-tub, gleaning the imperceptible elements of the best manure from soiled linen, its fertilizing power is vastly increased. Indeed, we may almost say that the average soap-suds from the kitchen and laundry is worth more than the soap which produces it."

If, however, these slops be allowed to enter the earth-pipes, the kitchen sinks should be provided with wire strainers, by which means the solid matters contained in the slops could be effectually separated from the liquids, and then placed in the garbage barrel, for removal by the scavenger. The liquid thus freed from the solids, along with the soiled waters, from the center of the city, should pass into the pipes, by the completion and extension of those already in use, beyond the city limits. Others may become necessary in the event the kitchen slops are not disposed of in the manner suggested. The pipes recommended by the City Engineer for this purpose would prove efficacious.

In all other portions of the city, save the central, the slops should be freed from the solids in the manner above recommended, and placed in the garbage barrel and removed by the scavenger. The liquid portions should be applied with the soiled waters to the soil, with which it should be intimately mixed.

Mr. E. S. Philbrick, City Engineer of Boston, in his article on "Defects in House Drainage," in referring "to the risks of leakage of drains," which are "of course, very serious," remarks:

"Those who do not wish to trouble themselves with such matters had better dispense with drains entirely, (that is, under, even, the sewer system) and do as in the days of our fathers, viz: carry the refuse water to a safe distance from the house in pails, where it can be consigned to mother earth."

Dr. W. Child, in an article on "Sanitary Measures in the Rural Districts," in speaking of the proper disposition of slop waters, asks and answers the following question:

What shall be done? Well, then, first, we may rid ourselves of the evil by the process called "soiling." This may be not only cheaply but profitably done. The only requirements are a garden conveniently near, a few rods of common spouts, and a few blocks of wood of convenient form and size. With these spouts properly supported by the blocks, the waste water may be conducted directly to all parts of the garden. After a few days the grease and soap carried along by and in the water will have been deposited upon the surface, so that the water will finally not soak into the soil, but collect in pools on the surface, either to evaporate or form an offensive mass of filth. But as soon as the water will not soak away into the earth, the end of the spout must be moved a few feet away, while the soil thus saturated must be thoroughly moved with a hoe. This operation may he performed again and again over the whole garden. Thus

you will destroy all bad influences that might otherwise arise from these waste matters, and also irrigate and enrich the soil. This plan, if faithfully executed, will surely and safely dispose of the waste water and other liquids from any common dwelling, boarding-house, or hotel, at least during the spring, summer, and autumn months. This is the cheapest and most effective plan that can be adopted for farm-houses and other isolated dwellings. The advantages of this plan are far greater than those of the common drain, with or without the well at its outlet. By "soiling," these waste waters are covered and absorbed by the earth, the best of disinfectants; the water and other liquids can never collect in pools, there to ferment and send off noxious odors and vapors, as they are sure to do with the common drain; the air can exert its full oxygenating influence upon these matters; the sunlight can exert its power, it and common air probably being the only real disinfectants; and, finally, the vegetation of the garden or field thus receiving these foul liquids will exert a powerful influence as disinfectants by absorbing and "assimilating the nitrogenous principles of organic substances."

In many cities the kitchen slops are utilized.

Their utilization is practical and economical. Dr. J. S. Schultz, late of the Board of Health of the City of New York, read a paper before the American Public Health Association upon the subject. He remarks:

"Some idea of the value of this refuse may be gained by the experience of some of our large hotels. In the city of New York these hotels sell their garbage for from $500 to $2,000 per year, to men who feed swine with it in the suburbs of that city. By an estimate during the year 1867, the average price paid for it was considered profitable to feed swine." "If the waste of a hotel kitchen is worth $500, then the garbage of an equal amount produced from family kitchens must be worth the same, less the extra cost of collecting." "There are a large number of men in our cities who support themselves by collecting and feeding the kitchen refuse, and if these men can make it profitable to do it in the way in which they conduct their collections, I feel certain that a more economical and wholesale collection must be profitable." "It is well known to all practical housekeepers in the country that a family of four or five persons will, from the kitchen, produce enough of vegetable and animal refuse to support *one pig*, and families of greater size will support two. But for the purposes of my argument and illustration, it is only necessary that I assume that each family can, by its animal and vegetable offal, support one pig. The most economical method of keeping swine is to keep them in the pen, or some confined pasture, and feed them from the *swill barrel*."

Thus it will be seen that the disposal of garbage and liquid filth does not interfere with the plans of conservancy suggested. Garbage, under any plan, must be removed by a scavenger force, and that this *necessary* force will be competent to carry into execution the methods of conservancy.

It is therefore believed that the following conclusions have been successfully reached in solving the sanitary problem of Atlanta:

CONCLUSIONS.*

1. That filth in all its forms is a deadly foe to human life, and must be speedily removed from human habitations to insure the healthfulness of communities.

2. That the water carriage system of removal however applicable to other cities is not adapted to the sanitary requirements of Atlanta. There is insufficiency of the water supply, and in consequence of the smallness of the rivulets into which the sewage must be discharged, they will become so largely polluted as to be converted into open sewers.

3. That conservative measures can alone give the true solution of the sanitary problem of Atlanta. They permit speedy removal of filth in accordance with the laws of health and meet all sanitary claims.

4. That conservative plans prevent contamination of drinking water; of subsoil water, and of the small branches flowing from the city as well as the contamination of the atmosphere.

5. That sewers are dangerous to health from sewer gases and the certainty, so far as Atlanta is concerned, of the formation of open sewers at the various outlets.

6. That sewage transported through sewers is worthless as a fertilizer however treated. That precipitating processes or sewage irrigation do not rid streams of polluting matters. That sewage irrigation of arable land is especially dangerous to health. That either of these plans are costly expedients, and have been abandoned as commercial enterprises wherever inaugurated, as well as having failed to secure the sanction of the sanitary authorities. That sewage irrigation of arable land fail to meet the approval of the ablest sanitary experts of the present day.

7. That the cemented vault system and removal by the pneumatic process, with either the dry earth or pail systems will prove the best means of improving the sanitary condition of our city. The latter system is especially adapted to the sanitary requirements of Atlanta.

*Since these conclusions were given to the Commission, they have, by consent, been amended and extended, in order to conform more exactly to the text of the report.

8. That these conservative systems offer the only means of converting fecal refuse and other decomposing matters into a valuable fertilizer.

9. That these plans are economical, and if properly managed will pay, not only expenses, but a revenue to the city.

10. That the disposal of garbage demands the organization of a scavenger force.

11. That liquid filth, and kitchen slops from the center of the city, deprived of its solid matters, may be permitted to enter our rivulets. Kitchen slops should however be utilized.

12. That these plans will, most effectually, secure the very best possible sanitary conditions for the healthfulness of our city.

13. That proper sanitary laws are imperative; that sanitary recommendations and regulations should be lodged in the hands of a legally constituted Board of Health, with a Sanitary Inspector to superintend the enforcement of all sanitary laws and ordinances.

W. T. GOLDSMITH, M.D.,
Chairman of Committee on Disposal of Refuse, etc.

Mr. McDaniel, City Engineer, read the following communication:

To the Sanitary Commission:

GENTLEMEN:—Having shown heretofore by the analysis of sewage water, by Prof. Way, in London, that sewage was quite as impure without water-closet connections as with them; and that sewers are a necessity independent of the disposal of excreta; as no other method has been proposed for removing the unclassified liquid filth, I make the following supplemental report on the disposal of excreta and sewage generally, with appropriate statistics. Having mentioned the precipitation plan in tanks, irrigation and "Leirnur's Pneumatic System" for excreta only, I address myself first to the impervious cesspool system.

In London, prior to 1815, it was illegal to pass fæcal matter into sewers, and they used cesspools under the houses or in close proximity thereto; the growing evils of this system were so great that about the year mentioned, the laws which governed were allowed to lapse by tacit consent of the au-

thorities. But not until 1847, did an act of Parliament make it compulsory to pass fæcal matter into sewers; and to this day London, the largest city of Europe is the healthiest and fewer zymotic diseases. Both Brussels and Paris, which have far more salubrious climates than London, have a higher rate of mortality, proving that the sanitary works of London are superior to either. London has sewers with water-closet connections exclusively. Paris has immense sewers, and cesspools also; showing conclusively that cesspools do not obviate the necessity of sewers; but in London sewers obviate the necessity of cesspools, and that too, in a sanitary point of view. Within a very few years Paris organized a gigantic nuisance by hauling the contents of the cesspools in night carts and discharging them into a series of basins at Montfaucon, close to the barriers of Paris, on the north-east corner of the town; and there the said contents were allowed to dessicate by the simple action of the sun and wind, giving off during the operation, miasmas of the most repulsive character. Some of the best quarters of Paris were within range of these miasmas, and some of the largest hospitals of the town were equally within their influence; and fearful indeed were the ravages of the gangrene amongst the patienrs, when the wind set towards the hospitals, from these huge collections of filth.

At last, however, the municipality of Paris has been compelled to make a change in this matter; and it may be suspected that the daily extending application of the water-closet system has had much to do with it. The system now adopted is to bring all the carts to a large covered building near La Villette, and there the more solid matters obtained from ordidinary cessspools, are at once loaded into covered barges; whilst the mere liquid matters are received into large reservoirs, to be thence pumped to an establishment situated at Bondy, at a considerable distance from Paris, where both the solid and liquid matters are treated for the purpose of being converted into a manure which is highly esteemed in France, and sold under the name of *poudrette*. This conversion into a manure is effected by a company, and it pays to the town of Paris, no less than £5,400 per annum for the materials thus shipped to it; but it is not to be inferred from this fact that

the inhabitants of Paris are gainers to the apparent extent indicated by the sum above quoted, for the householders are obliged not only to incur a very heavy outlay for the construction of the cesspools, but also pay very heavily for their being opened and emptied. When, in addition to this expense to the town of pumping the sewage matters to Bondy, is taken into account, it must be reasonable to suppose that the ultimate cost of the French system of dealing with these matters, is at least as costly as precipitation or irrigation. As to the nuisance, both in private houses and in the manufacture of the manure, there cannot be a shadow of doubt as to the superiority of the system of removing house refuse by means of water. The results of the pumping operations between La Villette and Bondy merit consideration, but are not applicable to Atlanta. The pipe is 6¼ miles long and one foot in diameter, along which is a steam engine working some force pumps at the rate of about 131 cubic yards per hour.

At Ely, England, a system of filtration at the outfall prevents any serious contamination of streams. "At Lancaster (Mr. Burnell says) there can be no doubt of the complete success of the precipitation and purification of the sewage water as here mixed with the milk of lime." At Edinburgh irrigation has been in operation for over 35 years. The late Mr. Smith, of Deanston, says:

"The sewer water coming from a section of the Old Town, is discharged into a natural channel or brook, at the base of the sloping side of the town, at sufficient height above a large tract of ground extending towards the sea, to admit of its being flowed by gravitation over a surface of several hundred acres. The water as it comes from the sewers, is received into ponds, where it is allowed to settle and deposit the gross and less buoyant matter which is carried along by the water, whilst it flows on a steep descent. From these tanks or settling ponds the sewer water flows off at the surface, at the opposite end to its entrance. The water is made to flow over plats or plateaus of ground, formed of even surface, so that the water shall flow as equally as possible over the whole, with various declinations, according to circumstances, and it is found, in practice, that the flow of water can easily be adjusted to suit the declination."

The practical result of this application of sewer water is, that land, which let formerly at from 40s. to £6 per acre, is now let annually at from £30 to £40. That which is nearest the city brings the higher rent, chiefly because it is near, and

more accessible. "The average value of the land, irrespective of the sewer water application, may be taken at £3 per acre, and the average rent of the irrigated land at £30, making a difference of £27, but £2 may be deducted as the cost of management, leaving £25 per acre clear annual income due to the sewer water." Indeed part of the Earl of Moray's weadow gave as high as £57 per acre. There is practically no smell attending these operations, and its contact with large areas of land deodorizes and filters it, undergoing no risk to health. Atlanta is well adapted to this plan. There is a positive certainty of being able to save the pollution of streams and a strong probabilty that farmers will soon be glad to get so valuable a fertilizer as sewer water, free of charge.

Dr. W. T. Goldsmith, in his able report quotes reliable authorities on the unhealthfulness of sewers, principally in the United States. The plan proposed by me is intended especially to cover the defects pointed out; and I favor a correct system of sewers or none.

Now, as to water supply, according to estimates made for the Atlanta water works, South River furnishes 3,000,000 gallons daily to the reservoir; the capacity of the engine and pumps 2,000,000 daily. London has a population of 3,000,000, using sewers and water-closets entirely; the daily water passing through sewers 88,000,000 gallons, making 29⅓ gallons per head per day. Atlanta, with a prospective population of 60,000, and 30 gallons per head would require 1,800,000 gallons daily, assuming it to use as much as London, per head, which cannot be, as there will never be anything like a proportionate quantity required for manufacturing purposes. The water-closets only require five gallons per day. In Eubanks' Hydraulics it is stated that water-closets "are an ancient and probably an Asiatic device." The summer chamber of Eglon, King of Moab (Judges iii, 20–25) is supposed to have been one. They were introduced into Rome during the Republic, and those constructed in the palace of the Cæsars were adorned with marbles, arabesque and mosaics. At the back of one still extant there is a cistern, the water of which is distributed by cocks to the different seats. The pipe and basin of another have been discovered near the theatre of Pompeii, where it still remains. Water-closets seem always to have been used

in the East, and oriental travelers say numbers are erected near the mosques and temples. A similar custom prevailed in old Rome, Constantinople, Smyrna, and probably all ancient cities. In the city of Fez (Ogilby says) "round about the mosques are one hundred and fifty common houses of ease, each furnished with a cock and marble cistern, which scoureth and keepeth all neat and clean, as if these places were intended for some sweeter employment." As there has been some inquiry as to efficiency of the pipe system proposed by me, I will give the experience of George E. Waring, jr., C. E., in building a sewer at Saratoga, New York, which will relieve the doubts and fears of all. He says:

"The Sewer Commissioners of Saratoga, (with me as Consulting Engineer) have completed a main sewer more than two miles long, for the removal of the entire sewage, rainfall, and spring-water drainage of that village. The village is large and scattered, has an abundant water-supply, is so inclined that during showers its storm waters concentrate rapidly, and has, aside from its regular population, five or six enormous hotels, entertaining, when full, about as many thousand guests. The village brook, itself, being mainly supplied by spring water flowing from various points, over a wide district, is always a considerable stream. As it flowed through its old channel—a conduit with rough, loosely-laid stone side walls, and with a more or less irregular bottom—its sectional area was about five feet. During heavy rains it was about thrice this. From the very beginning of the work, we encountered the most violent opposition on the part of many citizens, who believed that the sewer contemplated (circular three feet in diameter) would be entirely inadequate, not only for the removal of the water of heavy rains, but even for the drainage of the hotels alone, or the carrying of the storm waters alone; and throughout its construction this main sewer has been derided as a 'cat-hole.' We were constantly reminded that one hotel had a main drain eighteen inches in diameter, and another a drain two and a-half feet in diameter, and that it was madness, with these drains as our guide, to attempt to accomplish the whole work with a three foot sewer; especially as our fall was said to be slight, one foot in four hundred feet. On the 9th of July, 1875, the connections were made with all of the hotels; the village brook itself was turned into the sewer at its head, and its insufficiency was to be demonstrated. After every available source of water had been drained, the depth of flow in the upper part of the sewer was six and a-half inches. Nearer the outlet, where the water had acquired its maximum velocity, it was only four and a-half inches.

"As this was not sufficient to wash out the few loose boards carelessly left by the workmen, a hydrant was turned on with a full head, and it had the effect only of raising the flow one inch at the upper end, and less than half an inch at the lower end of the sewer. On the 10th there fell a vio-

last thunder storm, flooding the street gutters to the top of curbstones, and when this flood reached the sewer, its only effect was to raise the flow, at the highest, less than two inches, justifying my original opinion that a two-foot sewer would have been more than adequate for all that was required of it.

"On the 30th of August the entire village brook, with its tributaries and its many springs, was turned into the three-foot sewer, near the water works, about one-half mile beyond the outskirts of the village. The effect of this addition was to increase the depth of flow in the sewer from six to nine inches, and to increase the velocity of its stream from 150 feet per minute to 185 feet per minute. I can excuse my course in recommending so large a sewer as one of three feet, only by the fact, that in the state of public opinion then, it would have been entirely impossible to secure the making of anything smaller.

"Local authorities are not always imbued with the true spirit of humanity; money considerations are with them often of greater importance than the question of life and health, and it not unfrequently happens that political capital is made out of sanitary agitation. The advocates of filth and dirt appeal to the breeches pocket--too often with success—thus fulfilling those lines of the poet Burns,

"Man's inhumanity to man
Makes countless thousands mourn."

"While authorities are inactive, disease and death are not."

But I wish particularly to say, that during the investigations of this Sanitary Commission, though I have not always agreed with them, I accord to each that sincerity of purpose I claim for myself; and though divided as the waves, we are united as the sea in good intentions; and when calm, sober reflection takes the place of turbulent debate, we will present a smooth, unwrinkled front in favor of sewers.

Respectfully submitted.

H. T. McDaniel,
City Engineer.

Meeting of the Commission, June 8th, 1876. Mr. DeGive read the following paper from the city of Paris, in answer to inquiries by himself in reference to the disposal of excreta, etc.:

DEPARTMENT OF THE SEINE,
CITY OF PARIS,
WATER-WORKS AND SEWERS DEPARTMENT. } CHIEF ENGINEER'S REPORT.

The annexed report of the Inspector of the Sanitary Service, having control of the removal of excreta in the whole city of Paris, answers nearly all the questions proposed by the Belgian Consul at Atlanta; but we think we ought to add a

few complementary explanations in relation to the first question.

The Consul asks "why Paris has adopted the cistern and tubs system, and excluded the fæcal matters from the sewers?" and he adds that he heard from an old citizen of Paris that the question had been definitely decided in consequence of a long experience.

It is not exact that Paris should have, after comparative studies, definitely admitted that system in preference to the evacuation of the fæcal matters by the sewers, and should have excluded in principle for the future this last way of removal. The truth is that in a past, which is not yet very remote from us, the city of Paris had no choice. Paris has about 870 kilometres of streets, and 70,000 houses. Among her streets some are very wide, and require two sewers. Therefore, if a general system of evacuation by sewers of all the fæcal matters was adopted, it would necessitate 1,000 kilometres of public sewers at least, and 70,000 branchings, amounting besides to more than 300 kilometres. Moreover, it would suppose a water supply abundant enough to dissolve and carry away rapidly the matters. Such a vast undertaking could only be the achievement of a long time.

At the beginning of the present century, Paris had a very small supply of water, and only twelve kilometres of sewers. In 1850 it was only a little over 100 kilometres of galleries, and not a house was in communication with it. It was therefore necessary for every house to store somewhere, for more or less time, the matters in a recipient, fixed or movable, wherefrom they would be removed periodically. During all that period nothing could be done except to regulate the application of this way of disposing of excreta, and this was done by an ordinance of 1819, establishing rules upon the construction of the vaults, and is in force to this day. Since 1850, it has been decided, in principle, that every public way should be provided with one sewer passing through the middle, where the street would be of a width of less than twenty metres, and with two lateral sewers when wider.

In 1852 a decree prescribed that, as fast as the construction of the sewers would progress, each house should be, within a fixed time, put in direct communication by a private branch-

ing, through which should be evacuated the rain and house waters. Simultaneously an abundant supply of water was provided. From this moment the city of Paris was reaching fast (although that was not the end directly sought by the establishment of the sewers) the point where one day it could be possible to remove the fæcal matters directly by the way of the sewers; and the question of doing it, which could not be raised in the beginning of the century, was forcibly brought for a solution based on principle. Now that Paris has over one-half of her sewer system constructed, (five hundred and eighty kilometres and one hundred and thirty-five kilometres of branchings,) it is, therefore, more than one-half of the city where the excreta could be removed by the sewers; but then arises another question, which complicates the case. The great general collecting trunk disgorges its contents below the city, not far from its limits, in the Seine River, on both banks of which is scattered a numerous population. The actual disgorging of the sewers, without solid matters, in the river Seine, altering gravely the waters for many kilometres, in the middle of populations, cannot be considered anything but temporary, and is in fact so. We are studying actively at present the means of stopping it by way of lifting steam pumps that would elevate and distribute for agricultural irrigation the whole of the waters collected by the main sewers. But until we have remedied the inconveniences of the actual system, and suppressed the mixture of our liquid matters with the waters of the river, it is evident that we ought not to aggravate it. Now, what would be the consequences of throwing the fæcal matters in the sewers and in the River Seine? Opinions differ. It is not demonstrated that fresh fæcal matters, dissolved in a very large amount of water before entering in fermentation, could have an appreciable influence upon a river. But, whatever it may be, a large portion of the population, and many members of the administration, have the conviction that it would have an influence, and this simple fact is enough to stop any contrary experiment. Therefore, when the using of the sewage waters for agricultural purpose, now yet of a restricted application, will have been demonstrated to be practicable on a large scale, then only the question of allowing the fæcal matters to be let out in the sewers will be proposed for solution. Then

also it is possible that this system be adopted, as, to this day, it has been left aside by the fact of circumstances that one day will disappear. The system in itself has never passed in judgment, and was, therefore, never condemned. In the meantime, as the private branchings are established, the work of removing human dejections is simplified by the use of filtrating tubs, which retain all the solid excreta, and allow the liquids to escape in the sewers. We have to-day in Paris ten thousand of these apparatuses, and their number increases every day.

THE ENGINEER-IN-CHIEF.

Paris, March 22, 1876. [Signed] COUCTRE.

INSPECTOR'S REPORT.

First Question—For what reasons has Paris adopted the system of cisterns and tubs, and excluded the fæcal matters from the sewers?

That system has always existed. The direct projection of fæcal matters to the sewers was never allowed, but we authorize the running in the sewers of the liquid matters at the time of their production by means of a special apparatus called filtrating-tubs.

Second Question—How do you empty the cisterns? *Ans.*—By means of a double action pump, moved ordinarily by four men, and extracting about 250 litres per minute.

Third Question—How often emptied? By whom? At whose expense? *Ans.*—When it is full, as there is no fixed time. The capacity of vaults above a certain minimum is left at the wish of the proprietor of the house. The removal is made by special contractors, duly authorized by the municipality, and under the control of its agent. The proprietor pays for it at the rate of three to five francs for each cubic metre.

Fourth Question—Do you deodorize, by which means, composition of it, at what cost of each cubic metre of disinfected matter? We deodorize with salts of iron dissolved in common water, and at 20°. This disinfectant costs five centimes the litre or decimetre cubic, and it takes fifteen litres to disinfect one cubic metre of matter.

Fifth Question—How many inhabitants can be served by one pump and its accessories? What is the cost of the apparatus complete? *Ans.*—In Paris we use no steam pumps, but

the hand pumps above mentioned. For a population of 30,000 it takes a gang composed as follows:

5	Working men, including one boss and five draymen.	
1	Pump with carriage and 100 metres of pipe, francs	2,700 00
8	Iron barrels, each holding 2 cubic metres, francs	1,600 00
1	Carriage for 12 barrels of 100 cubic decimetres, francs	800 00
14	Horses, francs	21,000 00
12	Barrels of 100 decimetre cubic, francs	240 00
	Buckets, ladders, ropes, etc., etc., francs	100 00

Sixth Question—How many inhabitants can be served by a cart removing from houses the tubs or their contents? *Ans.*—The execreta of one person being per day of 24 hours 1½ kilogrammes, one cart provided with or holding 12 barrels of 250 cubic decimetres each, making two trips per day, could not serve a population superior to 4,000.

Seventh Question—What substance is used to render cisterns perfectly tight? How are they closed? *Ans.*—We use burr stone, cemented with hydraulic cement, lined inside with same. We close the cistern with a trap of rock or cast-iron, fitting in a frame of same material, leaving an opening of one metre by 65 centimetres.

Eighth Question—How do, in summer, act the gases engendered in the cisterns? Do they not rise and fill cellars and houses? What is the capacity of cisterns? *Ans.*—The gases escape by a ventilating tube of 25 centimetres in diameter, beginning in the top of the cistern and rising perpendicularly to the top of the house above the roof it belongs to, or above the roofs of the next houses, if these are higher. The capacity of cisterns varies according to the plan; however, they cannot have less than two metres from top to floor, and two metres in the sides.

Ninth Question—What portable tubs are used? *Ans.*—Some iron tubs of a capacity of 80 to 100 cubic centimetres only, so as to handle them easily, and some wooden tubs of a capacity of 100 to 250 cubic decimetres.

Tenth Question—What distance from Paris are the substances carried, and how are they rendered inoffensive?

Ans.—They are carried eight kilometres from the city. The matters of the cisterns are disinfected at the moment of their extraction. The matters of the movable tubs are disinfected at the moment of their dropping in the tub. Five hundred

grammes of sulphate of iron in powder, put up in the tub before it is placed for use, are sufficient to attain that end.

Eleventh Question—How are the matters dessiccated?

Ans.—The matters are reduced to powder by depriving them of the most of their liquid. For that purpose three basins, or tanks, on different levels, are placed so as to allow the contents to drop from the superior to the inferior. The matters are put in the superior one. As soon as the solid matters have settled in the bottom, the liquids are allowed to flow in the inferior tank, from where, after a new settling, they are led out in the third tank, whence they escape, perfectly valueless, to the river. The basins after that contain but compact matters, with which are mixed absorbing material like muck, earth, etc. This mixture then goes upon a hard ground, where its perfect desiccation is hastened by shovelling, and sometimes by harrowing. When the reduction to powder, or poudrette, is complete, it is taken under shades, where it is put up in barrels or sacks, ready for the trade.

One cubic metre of matter gives about forty decimetres of powder. The cost of manipulating and carrying to a distance of eight kilometres the said one cubic metre of matter is nine francs. The powder, when ready for sale, has no appreciable odor or smell. As for richness, the pure guano is richer in fertilizing principles. Guano is worth in Paris 350 francs a ton, while the poudrette is worth from 55 to 60 francs per ton. For manuring crops we use 250 to 500 kilogrammes of guano, and 1,000 to 2,000 of poudrette.

Twelfth Question—Have the medical or the sanitary authorities, in the past or in the present time, discovered, stated or found that the system adopted by the city of Paris does produce favorable or unfavorable results upon the health of the people, and these results, are they the direct consequence of the system? If any unfavorable results have been produced, could not a remedy be applied to it?

Ans.—No special authority has ever been called to give an opinion upon that subject to this day, as the processes employed have nothing contrary to salubrity.

COMPLEMENTARY INFORMATION UPON THE THREE PROCESSES OF REMOVAL OF EXCRETA EMPLOYED IN PARIS.

1. Cisterns in masonry. Their cleaning is only done at

night, and the operation, sometimes long enough, is always disagreeable for passers-by and the people of the house. Each cubic metre extracted costs three to five francs.

2. Moveable tubs, in wood or metal.

These recipients can only be employed with success for houses of ten to fifteen persons. They are furnished, repaired, removed and replaced at the expense of the proprietor by organized companies. The annual price for rent and repairs is from fifteen to twenty francs, and the price of each removal of a tub varies between one and two francs.

The tubs cost to the companies:

Tubs in wood of 250 decimetres, cubic.....40 francs
Tubs in wood of 100 decimetres, cubic.....20 francs
Tubs in wood of 70 to 100 decimetres, cubic.....30 francs
Their average duration is six years.

3. Filtrating tubs.

The direct and permanent flowing of the liquids into the sewers is only permitted through these apparatuses, which, in consequence of their construction, retain only the solid matters.

They are generally employed in houses where they use water-closets. The space required for their location is very small, as they require only a room of one metre by one metre and twenty centimetres in height. They hold about 100 cubic decimetres; they cost forty francs and last about five or six years.

The landlord who wishes to use them must connect himself with the city water-works, and construct a branching to the sewers, and then oblige himself to pay, first, to the city an annual tax of thirty francs for each apparatus, second, to the cleaning company twenty francs a year for rent and repairs, and one to two francs for each removal of tub.

Besides the process of removal by hand pumps, heretofore described, a cleaning company uses also a system called atmospheric, for the extraction of matters from the cisterns. The barrels employed are of a capacity of four cubic metres, perfectly tight, and provided with two connections with valves, one under, the other at the top. The vacuum in each one is made at the headquarters of the company, situated about four kilometers from the center of the city. The barrel is con-

nected by the top with a water tank, and so filled while the air escapes by a small tube. When full, the tube and top connections are shut up, and the bottom connection is connected with a steam pump which extracts the water and creates a vacuum. That water is, at the same time, sent back to the tank for the next operation. As soon as vacuum is made, the barrel is directly trotted by three or four good horses, to the place where it is needed, and placed in communication by its bottom connection with a pipe which is plunged in the cistern by an opening left for that purpose in the top of the vault. The end of the pipe is provided with a grating to prevent the passage of voluminous bodies. When all is so fixed, the valve at the connection is opened and the matters do rush instantly in the barrel.

This system has for advantages, to give no smell and to do away with the necessity of disinfecting before the operation; but it has some defects: 1st. The barrels fill only to about two-thirds, as the vacuum cannot be perfect when they reach the place of action; 2d. The keeping in order of the apparatuses requires much attention, and therefore is costly; 3d. It is difficult to operate at long distances; 4th. The cleaning is imperfect, as the liquids only are pumped out. Therefore, to extract the solid matters, it is necessary to use the ordinary process of opening the cistern and disinfecting the pasty sediment.

The Inspector,

(Signed) GALLED.

The Engineer in Chief,

(Signed) COUCHE.

Paris, March 9, 1876.

Meeting held August 3, 1876, Dr. Rauschenberg read his second report, this being in answer to Dr. Goldsmith's conclusions, as follows:

ATLANTA, GA., August 8, 1876.

To the President and Members of the Sanitary Commission:

GENTLEMEN—In answer to the conclusions Dr. Goldsmith has submitted to you, as an expression of the cardinal principles contained in his report on the removal of offal and excreta, I respectfully beg leave to present to you the following: Dr. Goldsmith conludes,

1. "*That filth in all its forms is a deadly foe to human life, and must be speedily removed from human habitations to insure the healthfulness of communities.*"

If Dr. Goldsmith only intended to express his opinion on this subject, in common phraseology, the correctness of this first conclusion is admitted; scientifically considered, and as a guide for rational action in the initiation of sanitary measures its value is, indeed, very small. If filth, in the common sense of the word, were such a deadly foe to human life, it is hard to understand why a great many people live, and grow fat, during an average duration of life, instead of dying very young.

I think it essential to define what is meant by filth, and why, and when, it becomes injurious to human health.

The writer holds that filth, in a sanitary point of view, means principally vegetable and animal matter, which accumulates about the human body and the habitations of men, and which, under the influence of moisture and heat, is subject to early decomposition, and liable to find its way, in the form of gases, into the atmosphere, and otherwise, either dissolved or mechanically suspended, into the soil and water.

Organic matter, simply, as such, is not poisonous to the human system, but essentially necessary to its existence, as all our food consists either of vegetable or animal substances. Its decomposition and putrefaction is the essential factor in the production and development of disease, either directly by the emanation of noxious gases and pollution of the atmosphere, or incidentally, but as an essential accessory, by furnishing, either on the surface, or within the upper strata of the soil of a populous city, or within its wells, springs and water-courses, the medium in which the specific poisons, or the contagions of diphtheria, typhoid fever, cholera, yellow fever and zymotic diseases generally, find—as living cells, because only such can reproduce themselves—the conditions necessary for further development and multiplication. Science does not yet know the exact relation which filth occupies to the production of disease; but it knows, with unquestionable certainty, that only its removal before decomposition reduces the mortality of cities in some manner yet unknown, and that *only such removal can be recognized as a sanitary measure.*

Now; if filth, in all its forms, is a deadly foe to human life, and must be speedily removed, as Dr. G. announces in the above conclusion, why does he only provide for the removal of urine and fæces, and leaves all the liquid waste from house and kitchen, and everywhere else, with all its organic and putrescent material, to take care of itself, and to find its way promiscuously, somewhere, to stagnate either in the yards, street-gutters, or the imperfect sewers, and finally to contaminate the atmosphere with its nauseating odors, or the soil and wells with the products of its decomposition? Does he imagine that these liquid wastes are innocent, and can be allowed to pursue this course? If so, and if he has no better means to convince himself of the contrary, we respectfully ask him to examine the street gutters, alleys and back yards of the city, and he will find many places where, without the presence of any urine or fæces, by the sense of smell alone he can easily discover his error. Or does he venture to assert that his proposed weekly, or even semi-weekly, removal—if such be possible—of the contents of cemented privy vaults, or of the pails from earth-closets, or any other kind of privy, by carts, will accomplish this speedy removal as he calls it—or, better, that removal before decomposition upon which we insist? Can he deny that any one, who has even a limited knowledge of chemical processes, must acknowledge the fact that urine and fæces together cannot be kept in any vessel for twenty-four hours, at an ordinary temperature of the atmosphere, without entering into decomposition? Does he flatter himself that it will be possible for him, or any one else, ever to establish a system of cartage of excreta and refuse, for this or any other city, which will not leave the much larger portion of the urine, and a large share of the fæces, within her limits? And does he think that such a system, with all its sanitary imperfections, could be extended over a surface area of nine square miles, occupied by only 35,000 inhabitants, without an overwhelming, and, to the benefits derived from it, entirely inadequate expense? Or, does he entertain the opinion that any acknowledged sanitary authority would indorse him in recommending such an inefficient and expensive measure, when the existence of an artificial water-supply by water works, sanitarily and pecuniarily, demands, above everything

else, provisions for the drainage of all houses receiving water, in such a manner that this water, after it has received the domestic and industrial filth cannot pollute the atmosphere, the soil and the wells of the city: but is confined, with the least possible amount of loss, into definite channels, to be conveyed, as soon as it reaches them without delay, and with sufficient speed, by the simple laws of gravitation, beyond the limits of the city.

This is the only method by which *all* the filth of cities—a deadly foe to human life, as Dr. G. calls it—can be removed *before decomposition*, and any other direct mode of removal is much more expensive and superlatively less efficient.

2d. "*That the water carriage system of removal, however applicable to other cities, is not adapted to meet the sanitary requirements of Atlanta. There is insufficiency of water supply and the smallness of the streams into which the sewage must be discharged will cause them to become so largely polluted as to convert them into open sewers.*"

This conclusion of Dr. G. sounds indeed very ominous; but is nevertheless entirely erroneous and incorrect in all its parts. The language used in it solicits first, the question: "*Are the sanitary requirements of Atlanta different from those of any other city?*" To the best of our knowledge they are exactly the same, from the simple fact that they originate from the same causes, to-wit: from the congregation of a larger number of inhabitants on a comparatively small surface and the consequent accumulation of a large amount of all kinds of putrescent organic material round about the houses, within the soil and the ground water of the city, so as to produce very gradually, but surely, pollution of the atmosphere, soil and drinking water, and with it increased morbility and mortality. The prevention of these consequences of the density of population is the object of sanitarians in all cities alike, and Atlanta makes no exception. Therefore, means and measures, by which the largest possible amount of the filth, offal and putrescent material, subject to accumulate in cities, can be collected and removed in the least possible time, to-wit: "*before decomposition,*" and with the smallest amount of expense from the houses and streets of a city, prevented from letting the products of decomposition according to their nature, escape either into the

atmosphere, or find their way dissolved or suspended in water into the soil and wells, are alike needed in all cities to prevent this pollution and its consequences, and Atlanta, like other cities *needs nothing better, and certainly ought not to have something worse.*

The water carriage system, properly executed, is acknowledged to be that method, by which this complete and speedy removal is accomplished in the most perfect manner or at least as near so, as human expedients and contrivances can reach perfection. If introduced in Atlanta, it will sweep filth more radically out of the city than any other method, and will carry more of it further out in one hour than Dr. G.'s system of cartage will carry out in twenty-four, at little or no expense to the city over and above the interest on the cost of the sewers, as the water-works, wherever sewerage is introduced, will soon, to say the least of it, pay their own expenses if not a handsome profit.

But Dr. G. tells us the water carriage system is not adapted to meet the sanitary wants of our city. He does not deny its usefulness directly, but says we ought not to introduce it: 1st. because our water-works will not furnish a sufficient water supply for a system of sewers; and 2d. because the streams which receive the sewage are too small, would therefore be polluted and converted into open sewers.

In answer to his first reason, concerning the insufficiency of our water supply, I must refer to the chapter on our water-works, contained in my first report made to you last May. There I have definitely shown by figures, that at a daily consumption of 35 gallons per head, the daily supply and capacity of the water-works is amply sufficient to supply a population of nearly fifty thousand inhabitants, and that such an amount is amply sufficient for complete sewerage and water carriage. If these statements, as to the capacity of the Atlanta water-works are incorrect, it seems to me that it would establish a good deal more disposition of fairness in Dr. G.'s argument if he would show by facts and figures that my statements are incorrect; instead of resorting to imperative, but nevertheless *vague* assertions. He calculates that the length of the sewers of Atlanta will, if all its present streets were sewered, be 130 miles, and in this great length of the sewers,

that the water supply will not be sufficient. This mode of arguing will certainly not hold good, if he will only recollect that water will run as long as it is kept on an inclined surface, and that the velocity, and hence the impetus and mechanical power and value of a column of water will increase in direct proportion with the length of the distance it runs, the fall even being the same, provided the sewers are built right, and only *such* we advocate.

His second reason why water carriage does not meet the sanitary requirements of Atlanta is, because it will pollute the small streams into which it has to be discharged to the detriment of the surrounding country, and even the city. This sounds plausible, but it is not exactly so, and if it were so, it would not be an argument against water carriage.

It is true that the branches into which the sewage of Atlanta has been discharged, and would have to be discharged, if we had a complete system of sewers, are small; but it is also true that there are five of them, at least; that they have a good deal of fall, and are generally swift running; that none of them go dry even in the most protracted spells of dry weather; and that none of them extend further than from six to ten miles from Atlanta before they reach respectively, either the South River or Chattahoochee, receiving all along their course new accessions of water from numerous tributaries, and thus, at a very reasonable estimate, doubling their volume of water at least every two miles of their course.

Furthermore, it cannot be denied that these small brooks are the natural channels which do now, and will for all time to come, receive and carry off all the rain and waste water, deposited on the surface of the city, as it is not likely that we ever will haul it off in carts, or that the law of gravitation will change so as to give it different directions. The question, therefore, is simply whether we will let this water have its own way to get there, either on the surface, in natural or artificial drains, in gutters, or through imperfect sewers, or finally even through the soil itself, and from there, with the groundwater, along the inclination of the geological strata, into one or the other of them. If we permit this promiscuous course to the rain, and waste waters of the city, they will partly stagnate here and there, in the back-yards and alleys, in the streets and

gutters, even in the imperfect sewers we have, and will leave a large portion of their filth more or less permanently deposited in our stiff clay subsoil, subject to decomposition, earlier or later, according to the temperature of the atmosphere, in these different localities, and only the main bulk of them, with a corresponding quantity of the city filth, will reach these brooks, where, however, it will not be deposited or remain at rest, as that does which has been retained in the city, but will, at least, be left in motion, and continually diluted by additions of new quantities of new water from tributary branches until it reaches, within five to twelve hours, and probably in less time, the South River, or Chattahoochee. Thus, if we leave our present sewers as they are, and do not build more and better ones—and Dr. G. does not only not consider it necessary, but injurious to do so—we will have this state of things well developed in Atlanta, to-wit: Pollution of the atmosphere, subsoil and drinking water, which good sewers would prevent, and, in the bargain, pollution of the streams, in almost the same degree, and, at least, as soon, if not sooner, as it is indeed very evident to me that all the decomposable filth of Atlanta, when emptied into them from a well constructed system of self-cleansing sewers, hence highly diluted, fresh, undecomposed and almost inodorous, would produce that pollution less readily and unfailingly than a smaller, but much more condensed and half-decomposed amount of sewage from filthy and imperfect sewers, as we now have. A good system of well constructed, self-cleansing sewers, added to our water works, will, in a very reasonable length of time, become the convenient receptacle of almost the entire mass of decomposable waste material of the city, except street garbage, and will enable us to put it in motion, and keep it moving out of the city, from the very moment it is deposited, at a velocity of at least one mile per hour, *by the cheapest motive power in the world—running water.* It will enable us to deliver our sewage into the natural channels in a state of high dilution, perfectly fresh, undecomposed and almost inodorous. Whenever it reaches them, it is not reasonable to suppose that the swift current they possess would allow any large amount to stagnate, but, on the contrary, will keep it moving on at a sufficient velocity, with continued additions of fresh water, and

hence fresh oxygen, from tributary branches, so as to protract the process of decomposition, and to place its commencement a considerable distance from the city, where the organic amount of particles in it is already so diminutively small, in comparison to the amount of water they are distributed in, that it will take many years and a large increase of population before this so much feared pollution, of which Dr. G. gives us such a horrible description, will, in reality, require consideration.

It is therefore my opinion that Dr. G., and all who advocate that the pollution of our water courses will be materially increased or hastened by the introduction of such a system of sewerage as I recommend, are decidedly mistaken. I do not deny that it has taken place in many localities, but I will be able to show directly that the want of good sewers, and other circumstances independent of sewerage, are generally the cause of it, and for that purpose I must beg leave to make a few quotations. The State Board of Health of Massachusetts, in its seventh report, January, 1876, in an article on the disposal of sewage, says of Manchester, England:

With a population of 356,600 people, living on 4,516 acres, a very large proportion of them being of the improvident class, this city adhered until quite lately to the cesspool system, discharging its surface drainage and kitchen waste into the rivers Irwell, Irk, and Medlock, which became filthy to the last degree. About 50,000 of the inhabitants, including those in the hotels, are now supplied with water-closets,* and from these also the discharge is into these rivers. The better class also live for the most part outside of the city limits; but whether inside or outside, they insist upon having water-closets in their houses.

In the vain hope of keeping the sewage pure enough to discharge into the rivers, the Health Committee have been abolishing cesspools and substituting the pail and cinder-sifter privies already described. These ash pits are very practicable where the water-carriage system is not practicable; but the method of emptying them is costly, and not entirely without offense. One hundred carts are constantly employed in Manchester, removing a mass of ashes and excrement, which has some high theoretical value. It is piled up just at the edge of the city, and in winter sells rapidly for a shilling and a half a ton. In summer the farmers give only a penny and a half, and during the busy season will not always give that.

As will be seen by the annexed plan, taken from the report for 1874, of Dr. Leigh, Medical Officer for Manchester, the ash-pit system requires the construction of sewers in order to carry off the fluid refuse, sink slops, etc. To connect these sewers with the houses of Manchester would require

* Since 1872 and 1873.

an outlay of 60,000 pounds sterling, of which the annual interest would be £2,400. The present annual cost of removing excrement by carts is about four times this sum, or £10,000, while Dr. Leigh, the Medical Officer of Health, in his last report, shows the necessity of purifying the sewage before letting it run into the rivers.

The rate of mortality in Manchester is still very high, although it has fallen about five per cent. in the last seven years. The city has an insufficient water supply, and is densely populated. These causes undoubtedly contribute largely to the high death-rate, although the latter has been attributed by some solely to the want of speedy removal of the filth by water-carriage. The ash-pits are emptied only once a week.

It will be proper to remind you here of the facts, that Manchester has been a manufacturing and growing city for several centuries, and is now a large city, with immense and varied manufacturing interests, producing hundreds of tons of liquid waste and offal daily; and that while its population is now more than ten times as large, the surface area on which it lives is at least 1,000 acres less than that of Atlanta. Furthermore, that the Irk, Irwell, and Medlock, while they are frequently called rivers, are in reality only sluggish running brooks, with very little fall, and with a small amount of water. Every one acquainted with the locality will acknowledge this statement as correct. These brooks are immensely polluted, but they became so in spite of ash-pit privies and direct removal by carts, because the liquid waste of the city was allowed, since time immemorial, to discharge into them, and in consequence of a combination of local circumstances, which can only be counteracted by the very means to which Dr. G. charges all river and stream pollution, to-wit: by a proper system of sewerage and water-carriage and purification of the sewage by irrigation.

Hence, river pollution is a natural consequence of the existence of large cities, and is certainly a smaller evil than intense impregnation of the soil and water of a city with foul organic substances, and wherever it exists *it certainly has generally been increased or made more prominent by bad sewers, or the want of sewers at all, than by such sewers as I advocate.*

London and the immense pollution of the Thames is frequently, but altogether unjustly, quoted by the opponents of sewerage—and, as a matter of course, by Dr. G. also—as an infallible evidence of the deleterious effects of sewers and water-closets.

It would require entirely too much space to enter into a detailed statement of the several very natural causes, which have gradually occasioned the pollution of this river to its present extent. I will therefore only mention the most prominent ones in the briefest possible manner, to establish the plain and undeniable fact, that this evil cannot be justly charged to such sewers and water-closets as I desire to be introduced in this city. Several thousand miles of the sewers of the city of London have been built in the course of several centuries, by the different wards of the city to suit their own local wants and ideas, without any general plan or system, and most of them are very deficient and of very faulty construction. Privy vaults and cesspools of the most imperfect character have within a few decades ago, been the principal recipients of human excreta, and a large portion of their already decomposed contents have for centuries overflowed into these ill-constructed sewers, and besides them the excrements of thousands of domestic animals and the offal of an immense number of mercantile establishments, workshops, and factories of all kinds, has been emptied into them. These immense quantities of all kinds of decomposable material arising from a densely crowded population, nearly four times as large as that of the State of Georgia, or as large as that of the States of Georgia, Alabama, Florida, and Mississippi, together, on a surface area not much larger than that of Fulton county; are there discharged into a comparatively small—and, by the addition of sea-water, brackish river, which contains very little more water than the Savannah river, at and below the city of that name, at the same time a river which rises and falls regularly by the effect of the ebb and flow, and whose shores at low ebb are twice daily, on each side, exposed to the breadth of about 100 feet, to the effects of the air and sun. The outlets of the large perpendicular sewers of the city are only under water at high tide, hence the sewage of the city has to find its way to the water over this bare and muddy surface twelve hours out of twenty-four. From the same cause the sewage emptied into it can only make its way very slowly towards the mouth of the river, as it has been definitely ascertained by repeated experiments, that it will take a log of cork-wood, thrown into it at the upper end of the city, two days and a half before it reaches

and floats away from the lower end. Hence, the filth of three millions of people, taking the population of some time ago as a guide, multiplied by $2\frac{1}{2}$, that is filth equivalent to the quantity that would be produced by seven millions of people is always mixed with the waters of the Thames, within its course through this city, and is continually moving backwards and forwards in consequence of the ebb and flow of the tide.

This was the condition of things until a few decades ago. Good intercepting longitudinal sewers, which receive the entire contents of the old sewers and discharge about 12 or 14 miles below, at Barking and Plumstead, into the river, and artificial embankments high enough to hold its water at high tide, so as to prevent the exposure of the river mud at low ebb, have already to a very considerable extent diminished, and will in due time almost entirely prevent the pollution of this river.

These statements, I trust, will make it plain that good sewerage and water-closets had nothing to do with the pollution of the Thames; that Atlanta, an inland town, with its 35,000, or in due time even 100,000 inhabitants, whose sewerage can be discharged into five branches, and will reach rivers of some size, within from five to ten hours, which are immensely larger in proportion to the number of people from whom they receive the sewage than the Thames at London; bears no analogy whatever to that city; and that the fear of an early pollution of our water courses is based more upon imagination than sound reasoning.

A proper consideration of the causes of the pollution of other prominent rivers—for instance, the Seine at Paris—would prove nothing more than what already has been sufficiently established, to-wit: *that direct removal of offal and excreta by cartage does not prevent river pollution, and that water-carriage and proper sewers enable communities to control their liquid wastes—including urine and fæces—and dispose of them in the most rational manner, and with the least injurious effects upon water courses and streams.*

I have often alluded to the enormous mechanical divisions and dilution of urine and fæces when removed by a system of water-carriage. The fact that their quantity, to the amount of water they are contained in is so small that they cannot be

detected by sight, smell, and hardly by taste, is amply illustrated by the following statement. I have before me a tabular and very detailed statement relating to the water supply of one hundred and fifty-nine cities of England, and from it and other sources I know that whenever more than from thirty to thirty-five gallons of water are used daily as the average quantity per head, this surplus is, sanitarily considered, a harmless but unnecessary waste. I therefore take thirty-two gallons, to facilitate the calculation, as the usual quantity of water used in cities per head. The weight of dry fæces per average human being is one-quarter pound; the solid residues of three pounds of urine after evaporation, another quarter pound; hence, one-half pound dry excreta per head. Thirty-two gallons, or four cubic feet of water, at sixty pounds per cubic foot, weigh two hundred and forty pounds, and one-half pound of excreta added to that much water will therefore constitute the 480th part of the entire mass. If we now take into consideration that this 480th part—partly in solution, partly in suspension—is kept in permanent and rather swift motion from the very moment of its deposit; that this mechanical division and oxygenation, by the oxygen of the water and atmosphere, will be not only permanently maintained, but duplicated at least every two miles, and still increased by flushes of rain, it can certainly not be hard to comprehend why sewage from self-cleansing sewers, even with water-closet connection, is almost inodorous, and does not pollute water-courses as fast as the opponents of sewerage and water-closets would have us to believe. These facts, and many others contained in my first report, I find fully confirmed in the Seventh Annual Report of the State Board of Health of Massachusetts, which was received only a few days ago.

At the end of a report on the pollution of the running streams and rivers of that State, which is certainly the ablest paper on the subject ever published in America, this Board of Health makes the following declaration: "Finally, the Board feel that in the present state of our knowledge, sweeping laws for the immediate and general purification of our streams would be hardly justifiable, and that they are not called for by the present condition of our rivers."

If that is not the case in Massacusetts, with only about one-

seventh part the number of square miles, but one hundred thousand more inhabitants than Georgia, and factories enough to produce a yearly value of five hundred millions of dollars, it will certainly be some time before it will take place in Georgia.

Sewage from self-cleansing sewers, with ample water supply, such as I advocate, sweeps all filth away, at a velocity of at least 120 feet per minute, or 7,200 feet, something over a mile, per hour. It is, in consequence of the enormous dilution it has undergone, fully as liquid as water itself, and subject to the same hydrostatic and hydraulic laws, runs fully as fast as water, and hence reaches its outlet almost perfectly inodorous, and, if the streams into which it empties have an uninterrupted fall, and a swift current, and allow no stagnation, over any extent of surface, it is, in my opinion, a matter of but small importance, whether they are small or large, contain much or little water, though the sewage is diluted to a reasonable extent, and kept in constant motion.

Hence, the sewage of Atlanta, from self-cleansing sewers, diluted by large quantities of water, as it will be if my plan of sewerage is adopted, will reach the outlet of the sewers inodorous, and when received and carried away at a fair velocity, even by small streams, with a swift current, as those we have are, being continuously more and more diluted by the water of tributary branches will reach larger streams, where its quantity of organic material will be proportionately too small to do any harm, even if it did not reach them long before its decomposition. Hence, it will not be a cause of serious pollution of our water-courses for some time to come, and the irrigation plan of purifying it will not be an immediate necessity, but will only recommend itself for early adoption, in the interest of agriculture and public economy.

I am firmly convinced that the percentage of organic matter of sewage from well built, self-cleansing sewers will decrease as the water consumption of a city increases, in the same manner in which a basin of water, which has served to wash off the entire surface of the human body, will contain proportionately more organic substance than the water of a bathing-tub would contain which had served the same purpose.

The observations of Dr. Bowditch, of Boston, Chairman of the State Board of Health of Massachusetts, (I. Report 1871, page 239,) in relation to the condition of the sewage at the outlet of the sewers at Barking, below London, are strikingly illustrative of the ideas I have advanced above.

The Doctor after speaking of the charges that have been made against the sewerage of London, to-wit: contaminating and filling up the Thames, etc., he says:

"But one can hardly see how, if sewage contaminations be pernicious to Londoners, they should not be so likewise to villagers.

I wanted to see and judge for myself, so far as I could by inspection and conversation with the inhabitants, what effect had been produced, and what would be the influence on my own senses of the emanations at the outset. Accordingly, I visited Barking, and fortunately met Dr. Parsons, the officer of the Union, in that town, an active, earnest and thoroughly accomplished physician, one too, who has the power to examine carefully facts, and to modify his opinion if need be, under the influence of facts. *He had joined* with his fellow-citizens in protesting against allowing London sewage to enter the Thames two miles below Barking. He felt persuaded that it must be injurious. He was called upon by the Government Commission to present facts, and he began to collect them under the impression that the result would be as he and his fellow-citizens had supposed. But he has found that death statistics do not at present (after a lapse of two years exposure) sustain that view. Seventeen per thousand living is the death-rate of Barking. He was surprised at this result.

He remembered moreover, that he had not been especially called to persons residing near the outlets, and there was no greater amount or peculiar character of diseases prevailing there than at other spots in his circle of practice. Dr. Parsons drove me to the outlet. Our course for nearly half a mile was directly upon the top of the drain. Every few yards I saw gratings of iron, which I learned were the ventilators of the sewer; but I observed no special odor arising from them as I expected. We were driving simply over a smooth greensward. Arrived at the mouth I placed myself directly over the partially running stream. It was low tide, and I could see the whole of the opening. I stood over the ventilator just above the gates, and where I knew that there was a large quantity of sewage water. I was still more surprised at the absence of odor in all these places. The keeper of the gates has a house and rears a family above and between them, and the outlet in the Thames. He assured me that he never has observed any peculiar odor, and that his family has enjoyed good health.

The inferences I was obliged to make, were, 1st: That by some means unknown to me, the excreta had become deodorized during the water carriage; and 2d: That at present there was no proof that this deodorized sewage water of London does actual harm to those living near it."

Since Dr. Bowditch wrote these lines, the fact that the sew-

age from self-cleansing sewers is inodorous, has become much more generally acknowledged amongst sanitarians, as the sewers of Hamburg, Dantzig, and almost all well-sewered cities of England have proven, and amply prove every day. That this is not the case everywhere, where sewage is discharged, is in all instances owing either to faulty construction of the sewers, deficient water supply, or both. The Board of Health of Massachusetts, in its Seventh Report, speaking of the irrigation farm at Gennevilliers, near Paris, for instance, uses the following language:

> When the farm was visited, there was what is called in England a stink over the whole place, which was attributed to three causes: 1. The sewers of Paris not being self-cleansing, the sewage has advanced somewhat in putrefaction before reaching the fields, etc.

This language of an authoritative body confirms my statements that sewage from self-cleansing sewers is considered inodorous by the sanitarians of the present day.

The great fears and horrible pictures in relation to the pestilent nature of our sewage, and its effects upon the health of the city at the outfall of the sewers, contained in Dr. G.'s first report, as well as his statements in relation to the insufficiency of the water supply furnished by our water-works, I must alike reject as incorrect, and the former as decidedly visionary and largely overdrawn.

> 3d. The conservative plans prevent contamination of drinking water, of subsoil water, and of the small streams from the city, as well as the contamination of the atmosphere.

The conservative plans are those, I suppose, by which excreta are removed directly, either by hand or machinery, and used for the preparation of fertilizers. The direct removal in buckets, the dry-earth-closet system, the removal from cesspools and vaults by the pneumatic apparatus, etc., are the modes of removal which Dr. Goldsmith enumerates under this head, and considers the great means by which all the sanitary deficiencies of Atlanta can all at once be supplied.

I have already stated, in my original report, that they are sanitarily the least efficient in the prevention of the contamination of the soil, water and atmosphere, and financially the most burdensome methods of removing excreta: 1. Because the collection and removal of the liquid and human excreta

by manual labor, or machinery, from a large city, is, on account of the inaccessibility of privies, and other causes mentioned in my original report, entirely too imperfect as to quantity, too slow to prevent decomposition before removal, requires more care and systematic management than can well be commanded.

As it seems, however, that my statements, even if they are the result of careful research, and represent the accepted opinion of a majority of the first sanitarians, do not seem to appeal forcibly enough to the common sense of our commission, I will adopt the more popular and less troublesome method of quoting the language of others on the subject.

Eigenbrodt, a German sanitarian, in his well known work,* says, on page 6:

"The bottom of all our privy tanks, even if it consists of well cemented masonry, becomes, almost without exception, pervious, as the formation of nitric acid salts will soon succeed to loosen the cement. The fluid substances therefore percolate into the soil a greater or smaller distance, according to its permeability. The main bulk of the gases formed in privy tanks, and the like receptacles have no other outlet, but through the privy tube into the houses, and, as there is a continual change of air between our dwelling and sleeping apartments and the other and colder parts of the house, they must necessarily find their way there. After, as is generally the case, having been considerably diluted by atmospheric air, our olfactory organs are frequently not able to detect them as such, but their presence in the atmosphere of our houses has been established beyond a doubt by the fact that bright silver-ware often turns dark, if exposed any length of time to the atmosphere of houses with such privy tanks."

I need hardly say that the presence of sulphurated hydrogen gas, one of the products of decomposition of human excreta, causes this change. Further down, on page 7, the same author says:

"The degree of contamination of the soil of our older cities is often strikingly exhibited when new houses are erected in the place of old ones. Not long ago, while digging out the soil to make room for cellars and basements, we had the opportunity to observe a vertical cut of soil of some extent, in the older part of the city of Dormstadt. The subsoil exhibited black streaks, of different breadth, running horizontally above each other. The same was observed at another place, and most prominently near an old, lately abolished, privy tank. After the great conflagration at Hamburg, the soil was found impregnated with a mineral hitherto unknown. On examination, it was found to consist of phosphate of ammonia and magnesia, and was called struvit."

* Die Stædterenigurg, etc. 1868.

In the Seveth Report of the Board of Health of Massachusetts, page 404 and 405, the following statement is made:

"In Cincinnati and Baltimore loose walled cesspools are common. In both cities a serious amount of pollution of the soil is said to have already taken place. That this pollution may exist to a great degree in a city, where the death-rate is low, as in London, is true; but there are so many sources by which putrefied organic matter from them may get into the water we drink or the air we breathe, that cesspools should be tolerated only in case nothing better could be got.

The Seventh Report of the Board of Health of Massachusetts, page 190, contains the following expressions in relation to the liability of privy tanks and cesspools, no matter how they are constructed, to leak and contaminate the surrounding soil and water:

"Now it is a very moderate statement to say that nine out of ten cesspools, the State over, do leak and are constructed expressly to leak and thus save the expense, labor and nuisance of frequent emptying."

Lower down this remark occurs:

"The action of frost, the jarring of the earth from various causes and imperfections in workmanship render it *impossible*, practically speaking, to keep cesspools *perfectly* tight."

In spite of all these facts, Dr. G. thinks the collection of fæces and urine in privy tanks, a sanitary measure, which ought to be generally introduced in the city of Atlanta to avoid water-closets and sewers which he deems extremely unhealthy.

Pettenkofer* has established the fact that in the city of Munich, Germany, not quite one-tenth of the human excreta are thus removed, and that at least nine-tenths find their way into the soil. This looks somewhat unreasonable, but an authority like Pettenkofer, now perhaps the most scientific and most accurate sanitary investigator and observer of Europe, cannot easily be doubted or gainsayed.

George Varentrapp, in his celebrated work on the drainage of cities, page 44, alludes to the report of the world-known sanitary engineer, Wiebe, containing a description of the poudrette works at Bondy, near Paris, which in nearly literal translation, sounds as follows:

"A visit to this establishment is at least very interesting, if it alone served the purpose of convincing the writer of the undescribable horri-

* Unkersurhungen ieber die Verbreitung der Cholera, page 13.

bility of the stench with which they contaminate the atmosphere, at a considerable distance all around. The author of this communication has been in many sewers, has walked over miles of subterranean canals, has become acquainted with the subterranean basins of crosness, the 1,040 square feet of surface contents of which are covered with a portion of the sewage water of London, of which 10,000 cubic feet are pumped to the sea in every minute; but has never before in his life, smelled anything which *distantly* reminded him of the stench at Bondy. It was, even after having been for hours in the open atmosphere with a heavy wind blowing, impossible to return to Paris in a railroad car occupied by any one else, etc.

This state of things, as far as odors are concerned, is even worse than what Dr. G. apprehends in his original report, at the outfall of our sewers in Atlanta, if we build such, with the only difference that the first is an existing reality, the second an imagination, unsupported by facts or experience.

From the report of the Prefect of Police of Paris, from the 4th of August, 1854—also contained in the above mentioned work of G. Varrentrapp—I add only a few sentences:

The direct removal system is a great inconvenience to the inhabitants of Paris. The means which are used to disinfect the substances do not prevent a putrid smell in the streets. The liquid constituents, after having been saturated with more or less neutralizing substances, are, under the supposition that they are odorless, allowed to run into the gutters, and disseminate their stinking emanations far and near. Mixed with residues of all kinds, intended to flow into the subterranean canals, they produce a degree of fermentation within them which intensifies the dangerous nature of the gases rising from them. The stirring of two hundred wagons, which are at work every night to remove privy contents, the working of the laborers, the loading of the tubs and the return of these ambulatory producers of unhealthy emanations to la Villette, fill Paris with noise, and the air with pestiferous odors. If these proceedings should increase instead of diminishing, the condition of things will soon be unendurable.

The Seventh Report of the Board of Health of Massachusetts (page 180) uses the following language in relation to the removal of excrements:

Of all forms of filth, the most dangerous, as well as the most offensive and most common, is fæcal excrement. Cast off by the human economy as not only incapable of furnishing any support, but utterly unfit to be longer retained in contact with the living body, it is nevertheless stored in the near neighborhood of most dwellings and of many wells throughout the commonwealth.

The same state of things exists here, and my opponent, Dr.

G., desires heartily to perpetuate it, only under a little more fashionable cover. I will, however, continue my quotations from the above report:

It lies beneath privies or in the cesspools which receive the waste from water-closets, dissolving and oozing more or less rapidly into the surrounding soil, from which it finds its way into some neighboring well; sometimes rises in gaseous form, to poison the air; sometimes lies stored and lurking, to infect any dwelling, whose cellar may be dug into the ambush ground, with "mysterious unwholesomeness." If any portion of that which finds its way into drinking water, came from a person suffering with typhoid fever, cholera, dysentery, or with certain forms of intestinal worms, it sows the specific seeds of those diseases in many new victims, till they multiply themselves manifold. Investigations, carried to the point of demonstration in England, have shown that several severe and extensive epidemics of typhoid fever have originated in milk brought from many miles away in the country, and infected with water into which a most minute amount of typhoid excreta had been washed from an adjacent and neglected privy. There is no means known of purifying excrement on a large scale, except by the roots of growing vegetation, and it does not become us to be positive that even this method can be depended upon to disinfect that which carries the specific poison of cholera or of certain parasites.

The only proper way to deal with excrement is to carry it as fast and as far away from human dwellings as possible; and without doubt the best way to effect this is by a complete system of water-carriage. But such a system must be thorough, or it will expose us to dangers in our sleeping rooms. * * But the great majority of dwellings cannot be furnished with water-closets, and must depend upon some form of privy.

This sounds very much as if privies and privy tanks were only suffered as a necessary evil, where water-closets and water-carriage removal could not be had. Can this not be had in Atlanta? I leave this question unanswered here, as it has already been amply considered at other places in my report.

I therefore must look upon Dr. G.'s third conclusion, to-wit: that his conservative plans—so called, I suppose, because they conserve the filth in the soil and water—prevent contamination of the soil, water, and atmosphere, emphatically as an unpardonable error, when the amount of established facts, proving the contrary, is so overwhelmingly large.

4. "*That sewers are dangerous to health from sewer gasses, and the certainty, so far as Atlanta is concerned, of the formation of open sewers at the various outfalls.*"

When Dr. G. makes this broad assertion he merely does what many others have done before him. He enumerates the

evils of the old sewers, which still exist in many localities, and charges these evils alike to the modern sewers, which, when properly constructed, do not permit decomposition and formation of sewer gases to any extent. The existence of these evils in the sewers of certain localities, proves only deficient construction. If some houses leak, or do not allow a sufficient circulation of air, it does certainly not prove that houses cannot be built without these deficiencies.

At the International Sanitary Congress, at Brussels, in 1852, Lord Elrington, then President of the London Sewer Commission, said: "L'etat des egouts de Londres est honteux, abominable."* This enthusiastic defender of water-closets and self-cleansing sewers would certainly not speak in such terms of that which he desired to establish, but only that he desired to abolish, to-wit: badly constructed sewers.

Mr. Bagazette, the enginer, who was entrusted with the construction of the great longitudinal sewer canals of London, says in a report, on the 9th of August, 1867, in relation to the sewers of London, generally:

"Besides the late eighty miles of sewers for the reception of surface drainage, etc., London has over 2,000 miles of old imperfect sewers, which have been built in course of generations to supply local wants, and of which very many are of exceedingly deficient construction."

Varentrapp, who states these facts, then continues:

"It is time, and even highly desirable that those who know nothing either about the old or the new sewers, and who, it seems, have no conception of the material difference between them, should cease to ascribe the results of the deficiencies of the badly constructed sewers to those which are constructed on correct principles, and should learn to comprehend the fact that the advocates of water-closets and sewers had already recognized these evils, and were engaged in remedying them long before they became participants in the controversy."

No member of this Commission will be astonished if the humble writer of this report assures them that he joins the distinguished author of the above lines in his wish, from the very bottom of his heart.

Eigenbrodt, in his work on the cleansing of cities, mentioned already several times in this paper, says, on page 65:

"Facts establishing the durability and sanitary efficiency of regularly constructed sewers, beyond all doubt, have been furnished quite lately. The report of a commission appointed by the Association for the Promo-

*See Varentrapp, Die Stædereinigung, page 121.

tion of Industry, at Altona, on the 10th of May, 1867, gives them, and moreover, of the most convincing character. The entire system of sewerage of Hamburg, planned and executed in 1842, by the well-known English engineer, Mr. Lindley, was by that commission thoroughly examined. The result was, the apprehension that the liquid contents of sewers would penetrate their walls and infiltrate the surrounding soil has proven unfounded after an experience of ten years in Altona, twenty-five years in Hamburg. * * * Accumulations of fecal, or other solid, substances, were not discovered anywhere, and the air within was almost entirely inodorous."

Eigenbrodt, after this, concludes that:

"After such well authenticated conclusions of a commission, which, in consequence of its composition, was, by no means, prejudiced in favor of the sewers of Hamburg, all the fears and apprehensions that modern built sewers, in spite of all care of construction, would finally become as permeable and leaky as the old ones, loose their significance and after such an experience it becomes the duty of all, and, in particular, of sanitary and municipal officers, to see to it that hereafter no more sewers are put up after the old and worthless construction, as all experts have condemned them, as dangerous to health, even if they are intended to carry only wash and kitchen waste."

These quotations should convince Dr. G. that good sewers can be built, and that the evils he attributes to sewers can be avoided, and have been avoided, wherever a proper understanding and good will are on hand to accomplish this object.

5. "*That sewage passing through sewers is worthless as a fertilizer however treated. That precipitating processes or sewage irrigation do not rid the streams of polluted matters. That sewage irrigation is especially dangerous to health. That either of these plans are costly expenditures and have been abandoned wherever inaugurated.*"

This remarkable conclusion of Dr. G. contains quite a number of items which for the purpose of preventing confusion, will as far as possible be considered, each one to itself.

How, and from whom did Dr. G. learn that sewage passing through sewers is worthless as a fertilizer? I have in no work, essay or paper seen any doubt expressed as to its fertilizing qualities.

In the Fourth Report of the Board of Health of Massachusetts, page 115, Phineas Ball, in a paper on the opportunity and possibility of utilizing sewage in the city of Worcester, says:

"There can be no doubt as to the value of sewage, *when used properly*, as an agent in the promotion of the growth of every crop useful to men."

Dr. Varrentrapp, next to Pettenkofer, the most reliable sanitary authority of Germany, if not of Europe, gives on page 65 and 66, of his work on the drainage of cities, from which I have quoted repeatedly, the theoretical value of sewage as a fertilizer, according to the calculations of Liebig and the analysis of Way. He puts it down to each average individual yearly, as equivalent to 66⅔ lbs. of Peruvian guano, or 12½ lbs of. ammonia, worth 8 shillings 4 pence per year. In relation to its practical value, he says that with proper irrigation establishments it is decidedly greater than that of the undiluted substances gained by direct removal, and on page 63, he uses the fllowing language:

"Nevertheless, we contend that the full fertilizing power of all the filth and offal of cities can *only* be preserved for the benefit of agriculture by the universal introduction of water-closets and systematic canalization."

Further more, he claims:

"That, as the transportation of the fertilizing substances of sewage water occasions no further cost, as the rain, kitchen, and industrial water must be removed from cities any how, the cost of irrigation, and where it is necessary, the elevation of the sewage by pumps, unless very considerable, is *always cheaper than direct removal.*"

Lower down in his work, page 32, he says:

"After the very definite conclusions of the English Official Commissions, and after all of which has been said previously about the different localities, it has been sufficiently established that sewage irrigation wherever it has been used a longer time, this usage has been an advantage to health, has served to keep rivers clean and promoted the interests of agriculture. *Only in this shape, all the fertilizing offal of cities can be transported to fields in a form inodorous, inoffensive to health, and at the same time most subject to be well and uniformly absorbed by the soil, and by roots of growing plants.*"

These expressions of Varrentrapp do not correspond with the views of Dr. G. and his authorities, although the reputation of the former as a sanitarian is world-wide and without reproach. This difference is indeed difficult to account for as it is not probable that Dr. G., or even the authorities he quotes from should have had more extensive or better opportunities for correct observation and information than he has had. But as this is *only a German authority*, not so well known and not so highly appreciated by many here as French and American and English authorities, let us look round a little

further and see what *they* are doing, and how they are thinking about this sewage and the value of irrigation; its purifying influence on the sewage on the one hand, and its nutritive effect on the irrigated plants on the other. In the "German Quarterly," for the cultivation of public health, vol. vii, page 24, we find a report of Prof. Dunkelberg's, on the sewage irrigation as it is practiced at Gennevillers, near Paris, and at Dantzig, Germany. He was sent by the Prussian Government to investigate and report on this subject, and the statements he makes emanate from the reports of French engineers, and are known to be correct and reliable. The following is an extract from his report:

"The first efforts of the Municipal Government of Paris to make 260,000 cubic m. of sewage, which empties daily into the Seine, near Clichy, innocuous or respectively to utilize it, was made in 1867, and consisted in the attempted disinfection of a portion of the water by sulphate of alumina, and the use of another for the irrigation of a small field. This field chosen for experiment lies opposite Clichy, on the left bank of the Seine, in a peninsula called Gennevilliers, which embraces more than 2,000 hectares of almost entirely level land, the culture of which has been entirely neglected, although its distance from the fortifications of the city is only four kilometres, from the markets only eight kilometres. The noted poverty of this soil accounts for the neglect in its cultivation, even so near the city. The subsoil consists of coarse gravel, deposited by the Seine centuries ago, which is only covered by a layer of sandy and poor loam, which, however, constitutes a very good filter to accomplish irrigation of the soil, as well as purification of the water successfully. The entire plain is not interrupted by a single hill, but lies, on an average, six or seven metres above the outlet of the canal, to which heighth the sewage has to be pumped by machinery.

From 1868, Mr. Mille and Mr. Durand Claye, from whose reports the following statements are principally taken, planned an irrigation project on the basis of the small experiments made the year before, which was submitted to the municipal government of the city. This aroused a perfect storm of petitions against irrigation. The municipal governments of Asniers, Clichy, St. Ouen, Argenteuil, St. Denis, the General Council of the Departments of the Seine and Oise, protested unsuccessfully against this project, and entreated even the Emperor with thousands of signatures; while, on the other hand, the inhabitants on the banks of the Seine protested just as forcibly against the continual flow of the sewage into the river. As it was impossible to satisfy both parties, and as the objections which were urged against irrigation became perfectly untenable under impartial consideration, the Prefect of the Seine, Hausman, in unison with the City Council, decided, on the 10th of July, in favor of the introduction of the plan of the above named engineers. Hence, from the first

of May, 1869, from 5,000 to 6,000 cubic metres of sewage water were daily pumped up by a forty-horse power engine. Two-thirds of this quantity were purified with sulphate of alumina; one-third was partly used to irrigate a surface of from five to six hectares (about 2½ to 3 acres), which the city had bought, and the balance turned over to from thirty to forty persons, who had the good will to support the plan of the engineers by testing it for irrigation. The results on this extremely poor soil were exceedingly satisfactory, and in spite of the continued agitation against it, the landowners clamoring for sewage water increased so that at the end of 1869, from thirty to forty hectares were irrigated, and the chemical purification became unnecessary.

The irrigation campaign of 1870 opened with the best prospects. The very porous soil absorbed yearly, per hectare, 5,000 cubic metres (161,730 cubic feet), and unusual crops—for instance, 70,000 kilogrames* kale, 60,000 kilogrames parsnips, 150,000 kilogrames turnips, and yields of from 6,000 to 8,000 francs per hectar—were obtained.

At the same time there was not the slightest sign of insalubrity perceptible, neither in winter nor summer. An entire village, les Gresillons, grew up round the municipal irrigation field; the rent of lands accessible to irrigation rose, and one of the richest manufacturers of perfumeries of Paris, Gerdin-Hadancourt, erected a factory right on the edge of the irrigation fields, in order to develop, either directly or with the aid of the gardeners, the cultivation of aromatic herbs, particularly the peppermint. In the face of these convincing facts, the opposition to irrigation naturally disappeared, and it became possible to think of extending it over the entire peninsula. A project for this purpose was planned and sanctioned by the Government on the 30th of July, when the war broke out, and put, with the subsequent seige of the city, a stop to all efforts in that direction. After peace was made, the landowners insisted again upon a restoration of irrigation. The former project was revived, and after the bridge at Clichy, which in the contest between the commune and the government had been blown up, had been restored, the arrangement was made to lay cast-iron pipes, of 1.10 metres in diameter under its floor, for the purpose of conveying the sewage-water pumped up on the right bank of the Seine to the left bank, and into the plains of Gennevilliers. A similar pipe was put under the bridge of St. Ouen, which conveys the sewage from Charonne, Belleville, and Montmartre, about 30,000 to 40,000 cubic metres daily, across the Seine. Another pumping station was established, and from the first of May, 1872, the sewage could again be conveyed to the plains, which had not been the case for twenty months, since the first of September, 1870. Hardly had the regular supply commenced, when 22 landowners, with 45 hectares, began to clamor for the sewage, and the machines had to work day and night, and 12,000 cubic metres had to be raised daily for several months to satisfy their wants sparingly, while in 1870, 5,000 to 6,000 cubic metres were fully sufficient.

The irrigation field of the city is considered a model garden, consist-

*1 kilograme equal to about 2¼ pounds Troy weight.

ing of six hectares, worked by several experienced cultivators. The florist, Howard, cultivates about 7,000 square metres, with ornamental flowers, and pays 500 francs rent. Vivet gets one price after another for his excellent vegetables; Forest and Chevallier raise fruit.

The time when the quality of products raised by irrigation was considered inferior is passed long ago. 450,000 heads of cabbage were sold at Paris in 1872 from these irrigation fields.

Private undertakers, however, have established the most successful methods of cultivation by sewage-irrigation, and also determined the crops and plants best adapted to that kind of cultivation. Fifty-one hectares are almost exclusively cultivated in vegetables and industrial plants. The ditches are mostly made with the plow, seldom by manual labor alone; the common expense per hectar for rent and cultivation amounts to from 500 to 700 francs, the value of the crops often to 2,000 francs. The cultivation of some vegetables is connected with an expense of 2,000 to 2,500 francs per year per hectare; but the value of the product reaches frequently 7,000 to 8,000 francs.

"Under these circumstances there was no cause for astonishment, if, on the part of private land-owners, petitions were made to furnish for the next year 83,495 cubic meters of sewage daily, for the irrigation of 571 hectares, and the results in that year were again as satisfactory as the year before.

"The Secretary of Agriculture has appointed a commission, with the vegetable gardener, Hardy, as president. This commission has established a great many facts in relation to this mode of cultivation. It has, also, been authorized to distribute prizes among the most intelligent and most successful irrigation farmers."

Further down, Denkelberg says, in the same report:

"Upon the whole, there is, with proper construction and direction of irrigation establishments, not the slightest cause to fear that the same would, in any way, injure the health of cities, either by foul emanations, or by contamination of the ground water. The rational construction of sewers establishing and securing the proper drainage of a city, and proper construction of irrigation ditches, according to quality of soil and crops, and finally the proper distribution, and repeated usage of water, etc., will furnish a sufficient guarantee against these evils. But all this can only be accomplished if the supervising engineer does not have to acquire the necessary knowledge by feeling and probing round at the expense of the city."

To continue to give you the more minute details of this report, or to undertake to give you translated extracts of the one about the sewage irrigation at Dantzig, would be too tedious, and require too much labor and time; but I give you only a few very short quotations in relation to the irrigation experiments at Dantzig, from the Seventh Annual Report of the Board of Health of Massachusetts, pages 393 and 394:

"When the English contractor, Aird, undertook to build the system of sewers so scientifically planned by Wiebe, for this city, of 80,000 inhabitants, they agreed to keep them in order, and to purify the sewage, by irrigation, for thirty years, at an annual expense to themselves of about $6,000 or $7,000, for keeping the pumps and conduits in order alone. They were to have the rent of 1,000 acres free, and all the income from the crops accrues to them. The sewage is carried nearly three miles, and is, at present, applied to 250 acres of what was, at the beginning of the experiment, almost a barren sandbeach, on the shore of the Baltic sea.

In 1872, the second year of the experiment, 15 acres were got under cultivation, and now 1875, 250 acres are covered with luxuriant crops, while some of the land has become very fertile. From a sanitary point of view sewage irrigation has proved a marked success at Dantzig."

Does all this lead you to conclude with Dr. G. that sewage is worthless as a fertilizer; that sewage irrigation is especially dangerous to health, and that it is a costly expedient and has been abandoned wherever inaugurated?

I quote further from the Fourth Report of the State Board of Health of Massachusetts, page 115, the following statement in relation to sewage irrigation:

"Success in enterprises of that kind in this country must be based on home experience; but when this is once attained every inland village, city and manufactory will regard it as a useful addition to their system of water supply and sewerage."

In the Seventh Report of the Board of Health of Massachusetts, in the description of the Breton sewage farm, near Croydon, England, page 358, we find the following:

"Under the Public Health Act of 1848, the authorities of Croydon built extensive sewers and connected water-closets with them, as the law compelled them to do. As the river Wandle, into which they discharge this sewage, is a mere brook, ankle deep in some places in summer, it soon became so polluted as to give occasion for frequent complaints. The various deodorizers, precipitants, etc., were then tried and proved to be failures. At last irrigation was begun in an experimental way, as there was absolutely no experience in any part of the world to serve as a guide. * * * * When the town was compelled by chancery injunction to purify its sewage, so as not to make a common sewer of the river Wandle, the first attempts at irrigation were attended with many failures, and at times a nuisance was probably created. Experience however has remedied all these defects; the farm is now free from odors, and there has not been a single complaint for several years, although there are many people living in the immediate vicinity, and the public road passes directly through the farm. Six houses, each renting at from £125 to £150 a year, have been built within a few rods of the irrigated land. A large orphan asylum is close to one boundary; and one-fourth of a mile distant twenty-five cot-

tages have been built. In all these places, typhoid fever is almost unknown. The workmen and the occupants of the cottages, use by preference, the purified sewage for domestic purposes. It looks clear and sparkling, has no especial taste, and more than satisfies the conditions of the Rivers Pollution Commission, and the brook into which it runs is literally filled with minute fish. The water is so clear and free from putrefactive ingredients, that a wealthy gentleman, living near by, has built a conduit at his own expense, to have it conveyed through his own grounds."

I interrupt my quotation here for the purpose of stating the fact that this very gentleman, who built this conduit had previously compelled the city by law, to empty the sewage into the Wandle below his park and fish-ponds for fear of sustaining injury. When convinced that his fears were unfounded he built the conduit spoken of to have the benefit of the purified sewage to increase the capacity of his fish-pond.

Does all this look like sewage irrigation was not a proper remedy for the purification of sewage and prevention of river pollution? But let us continue our quotation from above:

"Part of the land was originally bought for £160 an acre, the rest is leased at from £10 to £12 an acre per annum. Under such circumstances, and considering the fact, that the farm is carried on by a corporation and not by an individual, it is natural to expect that it would not be profitable. The loss is slight, however. * * * The crops raised look in admirable condition. * * * The party went away satisfied; that a sewage farm is not a swamp; that it does no injury to the health of the neighborhood; that it does not damage residential property, except from the ideal point of view; that it turns poor land into land capable of producing luxuriant crops; that its produce is beneficial to cattle, etc.; that the food is fit for human consumption; that a large farm cannot be managed successfully, except a large capital be invested in it; that the experience of sewage irrigation on the same land for fifteen years will justify the capitalists to invest in sewage agriculture under favorable circumstances."

Dr. Carpenter showed that the death-rates had diminished in the vicinity of the farm. This fact showed, at least, that no influence unfavorable to health existed there.

In the same report, page 345, speaking of the alleged ill effects of sewage irrigation, the following statement is made:

The testimony on this point is overwhelming. No cases of illness have been traced to emanations from well ordered sewage farms. Even in Edinburgh, where they are carelessly managed and foul smelling, this has been the case. In fact, during the cholera epidemics of 1859 and 1866, this region enjoyed complete immunity from the disease.

Those of the gentlemen who desire further testimony in

favor of the efficiency of sewage-irrigatiou, and in favor of the fact that it is the least expensive and the most efficient method of preventing water pollution, need but to read the article on Disposal of Sewage, by C. F. Folsom, M.D., Seventh Report of Board of Health of Massachusetts, page 276 to 402, and they can find more than I possibly can embody in this answer to Dr. G.'s conclusions. I will conclude with one more quotation from page 401, which reads as follows:

> Where sewage-irrigation is the cause of a nuisance, it will be found either to proceed from the use of old and putrid sewage, in large and foul open ditch-like carriers, or from open tanks and large carriers being allowed to become foul.

The Board of Health of Massachusetts, the numerous English Commissions,* who have extended their labors over many years, and were all composed of the best talent and gentlemen of the highest integrity, and also the German investigators, must indeed have overlooked a great many facts, or must have drawn very erroneous conclusions, as all of them do certainly *not* consider sewage worthless as a fertilizer, or irrigation with it dangerous to health, like Dr. G. and his isolated authorities do. It is of course left to the decision of this Commission on which side the most weighty argument and testimony is arraigned.

When Dr. G. calls the precipitation of fertilizers by chemical process a costly expedient, which has been, or—I would like to add—will be abandoned wherever it has been inaugurated, we fully agree with him, and it affords us some satisfaction to be able to do so at least in relation to ONE of his conclusions. No sanitarian will oppose him in this point. The Board of Health of Massachusetts, Seventh Report, page 398, says:

> Precipitation by chemical processes was referred to by Hoffman and de Witt in the report of the Metropolitan Main Drainage Commission in the following language, which fairly represents the opinions reached in France, Germany, and England: "The problem of profitably recovering the valuable constituents of sewage remains, up to the present moment,

* The reports of the Sewage of Towns Commission, of the General Board of Health, of the Royal Sanitary Commission, of the Metropolitan Drainage Commission, of the two Rivers Pollution Commissions, and of the medical officers of the Privy Council, were all in favor of irrigation, and only Dr. Lethby, from whom Dr. G. frequently quotes, is its main and almost single opponent in England of any note.

altogether unsolved, and very faint indeed are the hopes that the process of chemical discovery will supply the means of so doing. The valuable constituents of sewage are like the gold in the Rhine; its aggregate value must be immense, but no company has yet succeeded in raising the treasure."

In the present state of our chemical science, t'en, irrigation must be said to be the only method by which we can hope to get satifactory results in purifying sewage.

In full harmony with this opinion are those expressed by every English commission which has investigated the subject. The First Rivers Pollution Commission states, in 1867:

No arrangements for treating sewage are satisfactory, except its direct application to the land for agricultural purposes.

This opinion has undergone no change, whatever, up to this date. The sewage of Towns Commission has given the same opinion. In their second report they say:

"It is a matter of regret that so little progress has been made in the utilization of sewage in this way, since the period of our previous report."

In their last report they say:

"The right way to dispose of town sewage is, to apply it continuously to the land, and it is only by such application that the pollution of rivers can be avoided."

After all this overwhelming evidence, you will certainly not be astonished if I pronounce Dr. Goldsmith's fourth conclusion, with the exception of that part which relates to sewage precipitation, utterly erroneous, and propose to express the facts, acknowledged as such by the large majority of sanitarians, in relation to this subject in the following impartial conclusions:

1. Town sewage, when used for the irrigation of fields, is the most suitable medium gained by any method of removing offal and excreta, in which the largest possible amount of fertilizing material contained in these substances can be preserved and utilized in the interest of agriculture and national economy.

2. The fertilizing powers of sewage as well as the highly purifying effect of irrigation on sewage fluid, are established beyond a doubt, by well established laws of agricultural chemistry, as well as the results of experience.

3. Sewage irrigation is a late proceeding, and the laws and principles by which it shall be practiced with different kinds of sewage, on different soils, and in different climates, to attain

results, sanitarily as well as financially satisfactory, are not yet sufficiently understood and established to prevent failures in many localities; but abundant proof is now on hand to show, beyond doubt:

(*a*) That in all localities where sewage has to be purified to prevent pollution of water-courses, this object can be fully accomplished, sanitarily, by proper irrigation, with a much greater prospect of covering all expenses, and perhaps clearing a handsome profit, than from any other method of disposing of city excreta and offal; provided topographical obstacles, requiring machinery and labor for the elevation of the sewage, or the scarcity and high price of land do not necessitate the investment of too large a capital, in order to establish irrigation in a manner, which would satisfy the demands of hygiene and agriculture at the same time.

(*b*) That the net profits and financial success will depend entirely upon the degree of knowledge and judgment used in the preparation of the soil for irrigation, and the frequency and duration of the sewage application to the different crops at the different seasons, and that wherever this knowledge and judgment has been attained, sewage irrigation will become an infallible source of more or less profit to a large majority of the localities where it is practiced, and will, under the most unfavorable circumstances, be less expensive than any other method to dispose of the filth of cities.

In relation to Atlanta, I have already stated, in my first report, that I am convinced that there will be no difficulty to find localities to which the sewage can be carried by gravitation, and, at the same time, sufficiently large plats of land, at a reasonable price, to effect a thorough purification of the sewage. Some of the land might need underdrainage but upon the whole I am decidedly of the opinion that the sewage of Atlanta could be purified and at the same time profitably used for cultivation of vegetables and other crops, without a very considerable outlay of money.

6. "*That the cemented vault system and removal by the pneumatic process, with either the dry earth, or pail, system, will prove the best means of improving the sanitary condition of our city.*"

I have already in my original report as well as in this paper, amply shown that removal by hand or machinery is decidedly the most ineffective and least economical method of removing excreta and filth from a city and no sanitarian would think of earth closets, cemented privy vaults and pneumatic removal anywhere, where an ample water supply can be had or in any house where unsurmountable obstacles do not exclude the erection of water-closets.

Dr. G. troubles himself very much about the removal of urine and excrements, but he does not make a single suggestion in his report in relation to the removal of liquid waste and filth, and seems to think that the existence of a water supply by water-works is in the consideration of the sanitary improvements, our city needs a mere matter of moonshine. What is Dr. G. going to do with the polluted domestic, industrial, and street water of the city? Will he be good enough to tell us? Is he going to run it all into his cemented privy vaults, or does he consider our so-called sewers good enough for its removal? Does he deny the fact *that the liquid waste of a city with water-works is nearly as pregnant with putrescent matter without water-closet connection as with it*,* and requires good sewers as imperatively as if it received all the urine and fæces from a regular system of water closets. If he proposes to let all this liquid waste run into the cemented privy vaults, how large is he going to have them built. If he proposes to discharge them into our street gutters and sewers as they now are, and thinks them fit to receive and convey them, does he not constitute himself at once an advocate of deficient sewers and of the perpetuation of the very evils which he has so often

Composition of Sewage.		Average of 54 Specimens from 18 cities with water-closets.	Average of 38 Specimens from 15 cities without water closets.
Total of solid matters in solution		72.200	82.400
Organic carbon		4.696	4.181
Organic nitrogen		2.205	1.975
Ammonia		6.703	5.435
Nitrogen as nitrates and nitrites		0.003	0.000
Total combined nitrogen		7.728	6.451
Chlorine		10 660	11.540
Suspended matter,	Mineral	24.180	17.810
	Organic	20.510	21.300
	Total	44.690	39.110

The proportion of putrescible organic matter in solution was greater from sewage in the water-closet towns; but that in suspension was greater in the others. Of course, the total quantity of refuse discharged by sewers is less in the towns supplied with privies. The amount of sewage corresponding to 1.066 persons where water-closets are used is the same as that from 1.154 under the other system.

* This table, taken from the Seventh Report of the Board of Health of Massachusetts, exhibits the comparatively small difference in the composition *of the sewage* from towns with and without water-closets:

indignantly condemned, and with which he has so unjustly and indiscriminately charged the sewers, the construction of which we desire to effect by these reports? Or does he intend that the so-called sewers as they now are in Atlanta, can be allowed to remain, without creating from year to year a greater contamination of the soil and wells of the city, to such an extent, that the sanitary benefits caused by his pneumatic weekly removal of urine and fæces from cemented privy vaults, etc., would in comparison to the harm done by these deficient sewers, be so infinitesimally small andinsignificant that it could hardly come into consideration against the plain magnitude of the former?

The fact is simply: *water-works and sewers belong together*, wherever the former exists, the latter must be added sooner or later, hence Atlanta must have good sewers, and whenever she has them, she cannot only with impunity, but to her great sanitary and financial advantage, add water-closets and water-closet connections. Privy-vaults and inodorous pneumatic removal or direct removal with the pail system would indeed be an expensive and unjustifiable proceeding here, which, even if the common sense of the people would admit of its introduction as a sanitary improvement, could not maintain itself in execution, but the least imaginable length of time.

This is my firm conviction. Now allow me to quote a few authorities on the subject. In the last Report of the Board of Health of Massachusetts, the following statements occur:

> The earth-closet is tolerably familiar to us in this country, but here and in this country it is universally considered inferior to the water-closet in point of cleanliness and comfort, while scientific investigation thus far does not indicate that earth is any better as a disinfectant than water, if as good. Considering the trouble of providing sufficient earth (four pounds daily to each individual), the trouble and expense of artificially drying it, and the annoyance from frequent removal by hand of a large quantity of material, which has only a trifling commercial value, the earth-closet has always given away as water-closets have been obtainable.

Dr. Buchanan, in a report on earth-closets says, in the Twelfth Report of the Medical Officer of the Privy Council of England, page 80:

> If about one pound and a half of suitable earth, carefully dried, be thrown over a dejection, all smell from it is forthwith removed; and if the same quantity be mixed with half a pint of urine, the latter is absorbed.

Even on this estimate, which is very low, and assuming that four persons use one closet, every house would require for each closet about one ton of earth each year, making nearly 80,000 tons, or fifty acres of land about two feet deep for a city of the size of Boston.

The same report, on page 405, says:

Water supplies necessitate sewers, and sewerage systems, in most cases, involve pollution of streams. Offensive as this pollution may be, it is less dangerous to health than retaining filth about our dwellings in vaults or cesspools.

The same authority, on page 181, says:

The only proper way to deal with excrements and filth is to carry it as fast and as far away from human dwellings as possible, and without doubt the best way to effect this is by a complete system of water-carriage.

Further on, on page 190, the following statement is made:

Now it is a very moderate statement to say that nine out of ten cesspools leak, and thus save a good deal of the expense, labor, and nuisance of frequent emptying.

The same report, page 308, speaking of Pettenkofer, says:

To his surprise, he found that in Rugby, with water-closets, a liter of sewage contained 151 milligramms of organic matter, while in Munich, without closets, it contained more, namely, 189 milligramms. It appeared, too, that although it was forbidden by law to empty privy contents, etc., into sewers, it was done so much under the cover of darkness, that night-sewage contained 37 per cent. more of soluble organic matter than that of the daytime.

Rudolph Virchow, in his work, "Canalization or Removal," which considers the merits of each with unusual impartiality, says:

The advocates of removal forget too easy that mere removal by any mechanical means is not sufficient, but that besides it a system of sewers must be established, and that it is the next thing to an impossibility to keep them, even if they are intended to carry only liquid filth, free from urine and fæces. This uncontrollable contamination of the sewage constitutes in cities the most weighty argument in favor of the erection of self cleansing sewers, by which the sanitary control of houses will be reduced to a minimum.

Eigenbrodt, in his work on the cleansing of cities, after discussing the inodorous removal of the contents of privy-vaults by pumps, or by the pneumatic apparatus, says:

"Nevertheless all these efforts in relation to the improvement of the public health have but a nominal effect. A general and systematic execution of such sanitary rules is well near impossible, and the increasing contamination of the soil, water and atmosphere, from reasons already explained, cannot be prevented by such measures. In places where better

means cannot be put in operation, it is well enough to have new buildings supplied with the very best constructed privy vaults; but it is a deplorable waste of money and force when magistrates and officials endeavor to improve the public health by the improvement of privies. The experience of the city of Paris should be sufficient to prevent all others from following her example. The principles of public hygiene do not demand the improvement, but the entire abolition of all privies, privy vaults and pools."

Shall I continue to fill pages with quotations proving the inefficiency and expensiveness of every one and all of the different systems of mechanical removal of urine and fæces, when even common sense should teach any one that a complete system of sewers, receiving, by proper connection pipes, all the filth and waste of houses, from the chambers, bathing rooms, kitchens, closets, etc., in a liquid form, amply diluted with water, and carrying it by the power of gravitation, free of charge, at the rate of at least something over a mile per hour, outside of the city, is a much more effective and much cheaper method of keeping a city clean, than the everlasting and tedious effort of searching for and gathering up by hand or machinery, without the aid of water, to wash out and cleanse effectively, the urine and fæces from privy vaults and pools, in, under and round about houses, and often in localities more or less inaccessible? Who would think of such a measure in a city with an ample water-supply by water works, which, without a system of sewers could not exist any length of time without paying a heavy penalty in the life of her citizens? Strange enough that the chairman of the Committee on the Removal of Offal and Excreta, of this Commission, advocates and recommends such measures, in his fifth conclusion, as the best means to improve the sanitary condition of Atlanta Every dollar of money thus spent in Atlanta, would be a sinful waste, as it would merely procure what, with a proper system of sewers, nature furnishes herself, to-wit: *motive power.* When it is self-evident that such sewers must be built as an unavoidable supplement to the water works already in existence and when they can be made to remove all the excreta and waste from houses much more effectively than anything else, without any additional cost, who would think of establishing a separate, expensive, and, after all, mere nominal system of removing urine and fæces separately?

7th. That these conservative systems offer the only means of converting fœcal refuse and other decomposing matters into valuable fertilizers.

Dr. G. tells the Sanitary Commission that the refuse and filth of cities gained by direct removal can be profitably manufactured into valuable fertilizers, when indeed practical experience on this subject everywhere teaches definitely that neither is the case.

Does Dr. G. know of any city, here or in Europe, which manufacturers a valuable fertilizer from its refuse, and gains a revenue by so doing; or does he know any established sanitary authority which sustains his propositions?

Virchow, in his very excellent and most impartial works, "Abfuhr oder Canalization," 1869, says, page 22:

> Varrentrapp has established, according to my judgment, beyond a doubt, that financial results favoring direct removal and manufacturing of fertilizers at a scale that they would furnish a criterion for cities, have not yet been obtained anywhere. Agriculturally considered, we must confess that self-cleansing sewers, in connection with irrigation fields, constitute that form of usage of refuse and excreta which, for large communities, according to all experience, are connected with the least waste of fertilizing material and the most favorable financial results.
>
> Varrentrapp shows in his work, Uber Entwasserung der Stadte, "that in 1858 the houseowners of Paris had to pay an average of eight francs per cubic metre for the removal of excreta; a total amount of 3,469,984 francs; while in the same year the cash income from all the poudrette manufactured at Bondy was only 274,000 francs, leaving a deficit of the snug little amount of 3,195,984 francs as a pretty fair illustration of what the indulgence in the little hobby of removal and manufacturing of fertilizers costs that city on an average yearly."

Does Dr. G. deny these facts, or can he show that they have ever been proven by any one to be erroneous or false? Varrentrapp furthermore gives the experience of several wealthy stock companies, to-wit: La Societe generale des engrais Gounais, Le Compagnie Chaut fourniere de l'ouest, etc., which only shows that in spite of the large capitals which every one had invested, they all met with no success, but failed and suspended operations on account of it. On page 61 he says:

> In Germany the artificial manufacture of fertilizers from human excrements and other offal has, as far as we are informed, proved nowhere a profitable enterprise.

Still further down he remarks:

Thus we see that all poudrette factories have not paid, and are all gone to ruin; and where they still exist, the only reason for it is that the citizens are heavily taxed for the removal of the refuse.

Still further on he says:

The preservation of the full fertilizing power of all filth of cities can only be attained and used in the interest of agriculture by the introduction of systematic sewerage, with water-closet connection.

Hence, Dr. G.'s seventh conclusion is decidedly erroneous, and any system of direct removal would, sanitarily, be a farce, pecuniarily, a burden to the city.*

CH. RAUSCHENBERG, M.D.,
Chairman Committee on Sewers and Drains.

At meeting of the Commission, August 17th, Dr. Goldsmith proceeded to answer Dr. Rauschenberg's conclusions, as follows:

REPLY TO DR. RAUSCHENBERG'S CONCLUSIONS,†
BY W. T. GOLDSMITH, M.D.

To the President and Gentlemen of the Sanitary Commission:

I respectfully submit the following reply to Dr. Rauschenberg's conclusions.

FIRST CONCLUSION.—This conclusion contains several propositions asserting a general fact, viz: That all kinds of filth is dangerous to human life. It generalizes from many particulars; it presents to view: 1. The location and condition of privies; 2. Mode of disposing of their contents by burying them in gardens, near wells, etc.; 3. Liquid waste of houses, kitchens and water-closets—all of which contain more or less of solid organic matter; 4. The accumulation and stagnation of these in street gutters. Thus, in its sweep this conclusion embraces *all* the filth of our city.

The soakage of all these matters in the soil of our city, contaminating the water and air, is what is doubtless intended specifically to be the ground of the conclusion; the "burying of privy contents in gardens," and the "accumulation and

* This answer to Dr. G.'s report and conclusions was written to suit his report as it was when read before the Sanitary Commission. If his conclusions have been changed since, the writer had no opportunity to accommodate his answers to those changes.

† The reader is requested to refer to Dr. R.'s conclusions (page 27) in reading this reply.

stagnation of filth in street gutters," *are however alone mentioned in this connection.*

SECOND CONCLUSION.—It is not wise to convert "*gutters*" or *branches*—the latter of which Dr. R. does not refer to—into *open sewers.* The drains, (so-called sewers) of the city do admit of "percolation of liquid waste." They are not sewers. If they were *impervious*, they should not be used for conveying excretal refuse. "Gutters" should not be used for this purpose, for the reason that if it is contrary to sanitary science, by this means, to convert "gutters" into open sewers, the same law protests against the conversion of our rivulets into open sewers. Unless water-closets are used, so far as the so-called sewers are concerned, the increased consumption of water will have a beneficial, rather than a "deleterious" result. Because; 1st. the soiled waters will be more largely diluted by the increased quantity of water; and 2d. the increased volume of water will carry them away more rapidly.

The mortuary report of Atlanta, for 1876, shows a decrease in the death-rate, notwithstanding the prediction of Dr. R. and others, in the city press. In an article the writer gave it as his opinion that such results would follow the use of water by our citizens, provided that fecal matter was not permitted, by the increase of water-closets, to be poured into them, and that proper drainage was established.

The streets and street-gutters (to say nothing of yard-garbage, etc.) must have accumulations of filth under any and all systems of removal; hence, the necessity of a scavenger force, which Dr. R. nowhere notices or advocates in his report or conclusions. Water is the only power upon which he depends, or the only means he recognizes. It scarcely requires a word to show that water-carriage cannot remove all the filth of the city. Street filth, garbage, etc., under any system, must have men, horses and carts for their removal.

THIRD CONCLUSION.—The proper disposition of liquid waste has been fully shown in my report. Dr. R., in this conclusion, includes many kinds of filth under the head of "liquid waste." Would he have it understood that he advocates the putting of all these kinds of filth into sewers and thence into our runlets? Will he place in the latter the refuse of tanneries, slaughter-houses, butcher-shops, provision stores, house garbage and

"scrapings," and horse manure of the streets? Does he dispense with the scavenger entirely?

Much of these matters must be carted away, as every one well knows. Slaughter-houses, tanneries, etc., should not be allowed within or near the city limits. The Legislature should, by law, prohibit the location of these within certain distances of all our towns. The suggestion, therefore, that sewers are "indispensable" for the removal of all these various kinds of filth—styled erroneously "liquid waste"—does not give the true sanitary remedy, even under favorable conditions for water-carriage, or, at least, only in part and not as a whole, since the suggestion ignores the "indispensable" scavenger, and gives unlimited and unheard of power to water, as a filth removing agent.

Another error of this conclusion is the statement that "repeated chemical analysis" has "fully established the fact" that sewage composed of liquid waste alone is "nearly as richly supplied with organic and decomposable matter as if it contained the urine and fæces from the privies and water-closets in addition." If it were possible to put all the "liquid waste," under the classification of Dr. R., into sewers, the sewage would not then contain as much organic matter as the fæces and urine added. This is patent on its face. If, then, only the soiled waters, as suggested in my report, are allowed to be turned into our rivulets, the error of the proposition will still be more apparent. Taking the analysis (by Dr. Letheby) of the "complex" mid-day sewage of London as a basis of determining the amount of organic matter, in pounds, to every 1,000 persons, and it shows, in 3,750 gallons of sewage:

Excretal organic matter in solution	73.3	pounds.	
Excretal organic matter in suspension	35.6	"	
Total	108.9	"	108.9 pounds.
Organic matter from all other refuse, in solution	7.5	"	
Organic matter from all other refuse, in suspension	50.7	"	
Total	58.2	"	58.2 "
Excess of excretal organic matter over other organic matter.	50.7	"	

This is from sewage containing organic matter from all conceivable sources, as well as at the time of day when in largest

quantity, and shows the fallacy of Dr. R.'s statement. No analysis, however, can determine the existence of zymotic poison in sewage. It is a factor as yet undetermined by any known test—but it finds its place in excretal organic matter.

Now this statement of Dr. R. is founded upon the one noticed in my report, which was so thoroughly and ably refuted by that distinguished English chemist, the late Dr. Letheby, of London, viz: That streams flowing by "midden-towns" (Atlanta is not a midden-town) contained as large quantity of organic refuse as those into which sewage, containing the fæces and urine, was discharged. If this is not true of midden-towns, it cannot be true of any town where the fæces and urine are not permitted to enter the sewage composed alone of soiled waters. If, on the other hand, it was true that these waters contained nearly as much organic matter without the fæces and urine, it would not be logical to conclude that the latter should be added to them, even upon the assumption that these kinds of organic filth were equally dangerous to life. But every sanitarian knows that excrement contains the most dangerous qualities of any organic filth—the germs of zymotic poison.

If "liquid waste" is powerful enough to contaminate and pollute the soil and water of a city and must not therefore be allowed to diffuse itself over the surface or soak into the soil or find its way into imperfect sewers, why pour all the liquid waste—as classed by Dr. R., into the five small branches near by the city? If this "liquid waste" is so dangerous an element of disease, why add to it the fæces and urine, the most dangerous of all organic, decomposable matter?

Under the head of "liquid waste," Dr. R. blends—as before noticed—various kinds of filth. It includes, apparently, street filth and garbage of all classes: horse manure, (on streets,) the contents of "tanks, cess-pools and street gutters" of "provision stores, slaughter-pens and butcher-shops." Without any distinction in these kinds of filth he asserts "the possibility of removing it (them) effectually" "and automatically by the force of gravitation in properly constructed sewers!" And, as a deduction, announces the opinion that "*sewers are an indispensable necessity for Atlanta*"—*i. e.*, for all the above mentioned kinds of filth—"*even if the water-closet system and its connections with the sewers should not be introduced and the excreta should be prevented from entering them ! !*"

FOURTH CONCLUSION.—The exceedingly dangerous character of excremental filth is so evidently ignored in this conclusion (and in all others of these conclusions) as to impress one with the belief that Dr. R. does not believe in the dangerous disease producing qualities of excremental filth. He gives no opinion other than that all *organic* filth—from whatever source—is equally dangerous to life. This is the *basis* of the conclusion under notice. In my report facts are given, showing that excrement is the most dangerous filth with which the sanitarian has to deal.

SUB-DIVISIONS OF FOURTH CONCLUSION:

Dr. R.'s advocacy of water carriage rests upon the theory that under all conditions and circumstances, and in all places, it is the only system that can give perfect satisfaction. In his view the system can be applied anywhere and everywhere. He neither stops to consider *conditions*, nor to interrogate the facts upon which these conditions must be made to harmonize with natural laws. He casts all these aside and plants himself upon the proposition, that for all towns, the only perfect system of removal of filth is to be found in water gravitation. By reference to my report, it will be seen what conditions are indispensable for the perfect working of this system.

In these conclusions, which epitomise the points in his report, Dr. R., according to a fair interpretation, bases his whole argument upon three propositions:

1st. That all kinds of filth are *equally* dangerous to human life.

2d. That all this filth must be speedily removed from human habitations.

3d. That *all this filth* can alone be successfully removed by water-carriage, without regard to conditions.

As corrollaries to these propositions he asserts:

1st. That sewers are "indispensible," for the reason that "liquid waste"—embracing diversiform kinds of filth, some of which requires for its removal the *scavenger*, and not water—must be carried away by them, even if water-closet connections are discarded.

2d. That water-closets must follow water-works as a necessary result.

3d. That no plan of conservancy can be *successfully* adopted in lieu of *water-carriage in the removal of* excretal refuse.

In my report—to repeat—the disease-producing qualities of excrement is shown; and the fact fully established by many of the most eminent of the sanitary authorities of America and Europe, that epidemics of zymotic diseases depend mainly upon excremental filth—which shows the first proposition to be erroneous.

The second proposition is true—as stated in the first conclusion of my report.

The third proposition is a mistake. The success of water-carriage depends upon conditions, and it is shown in my report that, according to the best sanitary authorities, these conditions *do not exist*, in order to make the system successful, in and around Atlanta.

The first corrollary is also a mistake: 1st, because all the filth classed "liquid waste" cannot possibly be turned into sewers. Garbage—street filth—etc., must be removed by the scavenger; 2d, because it is shown in my report that an expensive system of sewerage is not necessary for the removal of soiled waters, and therefore the assertion "that it will be required even if the fæces and urine be excluded from the sewers," is founded in error.

The second corrollary is also an error—as has already been shown, and more fully so in my report.

The third corrollary is incorrect. It was shown in my report, from the testimony of the highest sanitary experts—all of whom are advocates of water-carriage under favorable conditions—that other systems—plans of conservancy—meet fully and completely the sanitary requirements of communities. It was also proven, beyond contradiction, that conservatism in German and English cities has been successful, *not theoretically, but after actual experience and practical adoption.* These actual experiences have shown *the fullest sanitary results—results not excelled by water-carriage—and demonstrated financial success by mathematical exactness.* It was also shown that many large towns having water-works, "deliberately" refused to avail themselves of water-gravitation, which should convince Dr. R. that the "introduction and connection of water-closets with sewers does" *not* "recommend itself pressingly to *all modern cities,*" and certainly not to cities located as Atlanta, *where every one of the conditions for the success of that system are absent.*

SUB-DIVISION "*a*."—"Cost" is the theme of this sub-division. The cost of water-closets, sewers, irrigation farms, etc., has been discussed in my report, but as Dr. R. makes the cost of water-closets the central idea of this sub-division, an itemed (low) estimate of his system will be given.

Cost of water-closets, 5,000 houses, $50 each	$250,000
Cost of sewers—Dr. R.'s estimate	200,000
Cost of farms and preparation for irrigation	60,000
Cost of four steam pumps (and receiving reservoirs), $5,000 each	20,000
Cost of laborers, horses, wagons, etc. (annually)	5,000
	$535,000

The cost of litigation, by reason of polluting the five rivulets, cannot be given, but in England this has been enormous.

As stated above, it was shown, in my report, that many large towns in England, having sewers and water works, refuse to form water-closet connections, for the reason that they would not give up other systems and adopt one so expensive as water-closets. Some idea of the cost of these closets, to the people will be seen by the item above.

Dr. R. also asserts "that any other method, whatever, would require the same or larger expense for local fixtures." The error of which statement is apparent from the statement above, and is especially so as regards the pail system. Indeed the annual repairs of water-closets will be more than the original cost of the pail system. For the pail system there need be no new privies constructed,* as the pails, which cost but little,

* In the central portion of the city, where the premises admit of it, the cemented vault system, as recommended in my report, would give no greater cost than for water-closets. They should be made small, and the night-soil removed often, by the pneumatic process. In many of the houses of this portion of the city, where the premises would not admit of vaults, the earth-closet can be successfully employed. A portion of the interior of houses could be easily arranged for this purpose, occupying no more space than similar arrangements for water-closets. Mr. Geo. E. Waring, jr., in a recent article in *Scribner's Magazine*, in referring to the supposed difficulty in supplying earth-closets with earth, has this to say: "I have recently concluded an experiment of six years duration, the result of which seems to show that this objection to the adoption of the earth-closet system may be set aside, or, at least, reduced to such proportions as to make it unimportant. In the autumn of 1870, I had brought to my house, where only earth-closets are used, two small cart-loads of garden earth, dried and sifted. This was used repeatedly in the closets,

can be placed under the seats of those now in use, while this system pays all expenses, and will, if properly managed, give a revenue to the city.

By using this system, or the cemented vault and the earth-closet, the fæces and urine can be "completely" removed—

and when an increased quantity was required, additions were made of sifted anthracite ashes. I estimate that the amount of material now on hand is about two tons. We, long since, stopped adding to the quantity, finding that the amount was ample to furnish a supply of dry and decomposed material, whenever it becomes necessary to fill the reservoirs of the closets. The accumulations under the seats are discharged through simply arranged valves into bricked vaults in the cellar. When these vaults become filled—about three times in a year—their contents, which are all thoroughly decomposed, are piled up in a dry and ventilated place, with a slight covering of fresh earth to keep down any odor that might arise. After a sufficient interval, these heaps are ready for further use, there being no trace, in any portion, of foreign matter, or any appearance of odor differing from that of an unused fresh mixture of earth and ashes. In this way the material has been used over and over again, at least ten times, and there is no indication to the senses of any change in its condition." * * "My experience seems to demonstrate the fact that there is no occasion to carry away the product from the place where it has been produced, as, after a reasonable time, it has ceased to exist, and there remains only a mass of earth, which is, in all respects, as effective as any fresh supply that could be substituted." * * "My experiment proves that the amount needed does not exceed one thousand pounds for each member of the household, and that this amount once provided will remain permanently effective to accomplish its purpose." If an objection, however, should arise as to the difficulty of supplying closets with earth—which Drs. Buchanan and Radcliffe state is of no more difficult management than the necessary supply of coal for fuel—the same amount of space could as easily be appropriated to the use of pails, with properly arranged closets. Sanitary authorities inform us that these closets, properly constructed, with folding covers to seats, and close-fitting receptacles, give no offense and that the removal of the pails, closed with covers, through the houses give no unpleasant odors. The pails should be disinfected when placed in the closet receptacles, and their removal should be as frequent—even daily, if necessary—as the laws on the subject should direct. This removal can be effected without much additional cost, by the "indispensable" scavenger. Pail closets, thus managed, never create a nuisance, while water-closets are constantly choked, and are "delicate machines," requiring unceasing attention, and become, oftener than otherwise, as Dr. Buchanan affirms, dangerous nuisances.

It will be remembered, that English sanitarians insist upon water-closets being detached from houses, because of sewer-gas atmospheric pollution. No similar objection can be urged against either the earth or pail closets.

and by the pail system more thoroughly than by water-closets—"in due time."

SUB-DIVISION "*b.*"—As will be seen from the above, the water-carriage system is not, as asserted, "the only method by which a final abolition of tanks, cesspools, privy vaults," etc., "with their unavoidable pollution of the soil, water and atmosphere, can be abolished." A complete refutation of this statement will be seen by reference to "conservative plans," in my report. Vaults like those in Europe are not recommended.

The abolishment of water-closets, if a sanitary evil for Atlanta, should be demanded upon the principle and the high sanitary ground that no person has the right to throw his putrescent filth upon the property of his neighbor, to his injury. No man can exercise such a right according to any code of laws, civil or moral. If he insists in injuring his neighbor he should be "*forced*" to desist—and any law or any individual that would confer or exercise such a "right" would take a legal and moral "retrograde step."

Such a "right" would be to create, in Atlanta, a nuisance of fearful magnitude; the "right" to disregard all sanitary law; the "right" to "*force*" endless litigation upon the city, with the certainty of being compelled to abandon the system in the end.

Again Dr. R. asserts that European experience has shown "that water-closets can not be kept out of cities with water-works any length of time," when as before stated, many large cities having water-works and sewers "deliberately" refuse to use them.

SUB-DIVISION "*e.*"—The advantages of water carriage being conceded, its success must depend upon *certain well-defined conditions.* This has been fully discussed in the report, and effectually disposes of this part of Dr. R.'s conclusions.

SUB-DIVISION "*f.*"—Dr. R. having no where in his conclusions touched upon the inevitable pollution of the five runlets emerging from Atlanta—having, however, dwelt fully upon the pollution of water and air near our habitations by filth, which he shows to be so great a nuisance in *the city,* and yet, according to his theory, is a nuisance of *no great moment* just *outside the city*—concedes the fact by his advocacy of the supposed

remedy—sewage-irrigation. The impracticability as well as the sanitary and agricultural worthlessness of sewage irrigation for Atlanta has been fully shown in my report. This has been made so plain, it is believed, as to make it unnecessary to say more here.

FIFTH CONCLUSION.—This conclusion is proven to be erroneous by the want of the conditions necessary both for water carriage and sewage farm irrigation.

Therefore, the 1st, 2nd, 3rd, 4th and 5th recommendations of Dr. R., are unnecessary, and would prove expensive without profit.

6th recommendation, while purporting to adopt my method, does not do so, as the "less denser portions of the city" should employ either the dry-earth or the pail system of disposal.

7th recommendation is unobjectionable as to location of privies, but no privy system, without conservative plans—which are as cheap—should be tolerated.

8th recommendation: All the present forms of privies should be abolished; but the plan suggested does not come up to the sanitary requirements of our city. Excrement should be removed without the city limits, under the pail system, and disposed of as recommended in my report, or the earth-closet should be used, and the manurial earth applied to the gardens.

The last recommendation of Dr. R. is "the passage of a law by the Legislature making it a penal offence for any one in the county of Fulton to haul on wheels and unload privy contents or other putrid material and offal *into a running water-course, or within fifty feet of it.*"

This is a wise recommendation; but Dr. R. would subject himself—if not in the letter, at least in the spirit of the law—to "penal" prosecution under such a statute. For while his law would subject any one to "penal" prosecution by "unloading privy contents into a running water-course, or anywhere within fifty feet of it," he would violate the principle of his law a thousand-fold more by pouring the contents of the water-closets—with all the liquid filth, etc., of the city of Atlanta, with its 40,000 people—in the running water of five small branches! The *small* sinner would in this case be punished, while the *great* transgressor would escape under his

construction of such a law—i. e., according to his report and conclusions.

W. T. GOLDSMITH,
Chairman, etc.

[The following is the first report of the City Engineer, inadverdently omitted in the proper place:]

To the Mayor and General Council:

GENTLEMEN—Leaving the question of whether or not the health of the city is being impaired (by accumulation of filth, etc.) to the Sanitary Commission, the Board of Health, and this Council, I simply report on the most efficient and cheapest plan of getting rid of it, in as brief a manner as possible.

Atlanta is most favorably situated for sewers as a mode of transporting excreta, as has been frequently remarked; owing, of course, to the natural drainage, radiating, as it were, in every direction from a common centre, and with steep grades, thereby dividing the bulk of the matter to the minimum, and disposing of it with great rapidity.

E. S. Chesbrough, City Engineer of Chicago, the best construction authority, in his report refers to the disadvantage of constructing sewers in that city, owing to the flatness of the surface (the maximum grade being only one foot in 2,500, where we have twenty-five feet and over in 2,500), and after traveling over the United States and Europe, investigating before beginning the construction of sewers in Chicago, in 1855 he made a report which was adopted, and the sewers have been built, and have proven to be models, notwithstanding the great natural obstacles, which Atlanta has not. The system adopted differs in some particulars, but in this and other successful sewers no fundamental principles are contradicted, notwithstanding the problem is presented in a different shape in dissimilar places. It is undeniably true that a proper system of sewers always adds to the healthfulness of any malarial locality. Geo. E. Waring, Jr., C. E., says that in 1860 a defective system of ventilation of sewers existed in Croydon, and the mortality was very much increased until the proper alteration was made, and now it is exceedingly healthy; and Baldwin Latham, C. E., made a calculation of the cost and value of the water-works and sewerage of Croydon, as follows:

"Cost: purchase of land (for sewage utilization), £50,000; water-works, £70,000; sewers, irrigation works, baths, abattoirs, and general improvements, £75,000; total, £191,000." The money savings during thirteen years since the completion of the work, he estimates to have been 2,439 funerals, which would have cost £12,195; 60,975 cases of sickness prevented, £60,975; value of the labor for 6½ years of 1,317 adult persons whose lives were extended, $165,930; total, £240,100. He says: "Although it has been attempted to put a money value upon human life, we individually feel that life is priceless, and we may look to the 2,439 persons saved from death in this single town as the living testimony of the value of sanitary works."

In every case where sewers have been condemned, a defect in construction was the cause, and well regulated sewers exist to-day as guides for the future. I need not cite a multitude of statistics to such a well informed body as this, but will simply say, let the anti-sewer advocates account for the immediate healthfulness of places after perfect sewers have been built, by some strange phenomenon or coincidence beyond the realm of accident, is the necessary result.

"One of the most important items connected with sewerage," says Waring, "is the regulation of the sizes of mains and laterals. It is as much error to make sewers too large as too small. A brick will stand unmoved in a shallow stream running sluggishly through a 15-inch drain, while the same stream concentrated into a 5-inch drain would, by greater depth, force, and velocity, sweep the brick away." Again: "One principle is very apt to be disregarded in regulating the sizes of sewers: that is, that after water has once fairly entered a smooth conduit, having a fall towards its outlet, the rapidity of the flow is constantly accelerated up to a certain point, and the faster a stream runs the smaller it becomes; consequently, although the sewer may be quite full at its upper end, the increasing velocity soon reduces the size of the stream, and gives room for more water.

"It is found possible, in practice, to make constant additions to the volume of water flowing through a sewer by means of inlets entering at short intervals; and the aggregate area of the inlets is thus increased to very many times the area of the sewer itself. Where a proper inclination can be obtained, a

pipe 18 inches in diameter makes an ample sewer for a population of 10,000."

"The main sewer in upper George street, in London, is 5½ feet high and 3½ wide. In the bottom of this sewer there was laid a 12-inch pipe 560 feet long. A head wall or dam was built at the upper end of this, so that all the sewage had to pass through the pipe. The whole area drained was forty-four acres (built area). The velocity of the water in the pipe was found to be 4½ times greater than on the bed of the sewer. The pipe contained no deposit, and during rains stones could be heard rattling through it. The force of the water issuing from the pipe kept the bottom of the old sewer perfectly clean for about twelve feet below its mouth. From this point bricks and stones began to be deposited, and further on sand, mud, and other refuse, to the depth of several inches. In one trial a quantity of sand, bricks, stones, and mud, was put into the head of the pipe. The whole of this was passed clear through the pipe, and much of it was deposited on the bottom of the old sewer some distanse from its end."

The pipe was rarely observed to be more than half full at its head. It was found that the sum of the house drains delivering to this half full twelve inch pipe, was equal to a circle thirty feet in diameter. Sewage, though offensive, is not dangerous for two or three days, and water will remove it in a few hours, and before decomposition. In Atlanta, ventilation by main holes, every one hundred feet, would prevent the sewer-gas from forcing the traps in houses, and by adopting Latham's charcoal ventilation for the main holes in the cetral localities, the unpleasant odor is abated, and by these frequent openings, the gas is diluted sufficiently, as has been frequently demonstrated. In Croydon, their total cost, including labor, new charcoal, fuel for reburning, etc., made a charge of less than $1.25 per annum for each. The charcoal is reburned in iron retorts, having small pipes to carry off the escaping gases.

A compound system of sewerage is best adapted to Atlanta, under all the existing circumstances; that is, let the present system, carrying both flood-water and sewage, remain common as far as the south side of Fair street, at its junction with Loyd street; then continue from that point, with a pipe sewer, to the corporate limits, carrying all the branch water (except

floods) which will aid the water works very materially in flushing a pipe sewer. Where the large sewer connects (at Fair street,) the flood-water, after the pipe becomes full, will escape into the old channel; the large sewer then becomes only a matter of importance to the owners of the land, who may, as property enhances, be induced to sewer it, for the value of the land reclaimed over it. Let a sewer sufficiently large for both flood and sewage be built, or enlarged, on the natural drain, from near Ivy street, north of Decatur street, to a point two hundred feet northeast of Butler street, thence a pipe sufficient for sewage matter alone, to the corporation line, allowing the flood to escape as at Fair street.

In fact, these two points illustrate the plan proposed, the details being subject to surveys to be made. The pipes can be laid with main-holes, etc., for $11,000 per mile for mains and less for laterals.

The old sewers should be revised by having them in a concave shape, with good cement, and cement the sides inside a foot high. I simply make this "bird's eye" report to outline a system I have carefully considered. For argument's sake, suppose it should be determined, in fifteen or twenty years, to carry out the large and expensive system, the expense of taking up and utilizing elsewhere would be nothing, compared to interest saved, but the pipe system is cheapest and best.

H. T. McDaniel, City Engineer.

Meeting of the Commission held November 9, 1876, Dr. Rauschenberg read his final report, as follows:

Atlanta, Ga., November 9, 1876.

To the President and Members of the Sanitary Commission:

Gentlemen:—At the close of our discussions for the purpose of agreeing upon the means and measures, which will most effectually secure a permanent sanitary protection for the city of Atlanta, I beg leave to lay before you a condensed recapitulation of the relative views entertained and propositions made to you by Dr. Goldsmith, as well as myself, in order to give you the opportunity of easy comparison and discrimination in favor of the one or the other.

Dr. Goldsmith holds: 1. That the sanitary condition of the city can be promoted more effectually and with less expense

by the introduction of cemented privy vaults and removal by pneumatic pressure and, where that is not practicable, by the introduction of the dry-earth closet or pail system—the latter being in his opinion the best—than by any other process.

2. That notwithstanding we have an artificial water supply by water-works, there exists no necessity for sewers in the city, and that all the liquid waste and filth (except excrements) from the houses, kitchens, stores, workshops, factories, etc., can be allowed to enter into our present sewers, permeable and insufficient as they are, or can be carried off in the same natural or artificial channel now existing for the removal of the rain water from the streets of the city.

3. That sewers and removal of city filth of any kind, but principally urine and fæces by water carriage, are exceedingly dangerous to health *generally;* but in Atlanta *especially* as, in his opinion, the water supply of the city is insufficient and the water courses for the reception of the sewage too small.

4. That irrigation does not purify sewage; but is dangerous to health, and that even if sewers were otherwise practicable, the impossibility of purifying the sewage before it enters the small water courses, which have to recive it, would entail too great a pollution of their water, and hence, sewers would be a sanitary evil for Atlanta, instead of a benefit.

This is an impartial summary of the views Dr. Goldsmith has expressed in his different reports on the removal of offal and excreta, and I now respectfully ask him to make such corrections as he may think necessary, if I am mistaken or have misunderstood him in any particular.*

My own views in relation to the principles, which must govern the initiation of a wholesome sanitary policy for Atlanta are expressed in the following conclusions, which are again but a summary of my reports on the subject.

1. Dr. Goldsmith's proposed mode of direct removal of excreta either from cemented privy-vaults or in pails from earth, or any other closets, etc., is according to experience and well established principles of sanitary science not admissible as a sanitary measure, with a view to effective and permanent improvement anywhere in the city, where the presence of an

* Dr. G. assented to the correctness of this summary, and only had the words: the latter being in his opinion the best "contained under par. 1," added to it.

artificial water supply makes sewerage a necessity; but only in those localities, which have not been reached by that supply, as a temporary makeshift until the water supply and the sewers have reached them.

2. That whenever a city has water-works and an artificial water supply, good sewers become an unavoidable necessity, even if they are not intended for the reception of human excreta, because:

a. Water, which has been used for cooking, washing dishes and clothes, bathing and scouring, and for manufacturing and industrial purposes, contains filth and organic material in sufficient quantity to become putrescent and to contaminate atmosphere, soil, and water, if allowed to stagnate or to soak into the soil.

b. The quality of the water and the efficiency of the sewers, which carry it off; hence the sanitary and financial success of water-works and sewerage depend upon the quantity of water used and paid for; but without good sewers to receive the drainage from houses, the use of the water cannot become universal.

c. Common sense and common justice demand that the water used in each house should have a proper channel to run off in, to prevent it from swamping the surrounding soil with undue moisture, and to prevent the filth contained in it from penetrating the soil and contaminating the water and the atmosphere. Surface drainage alone would not answer that purpose, as the want of fall would in many places cause stagnating pools of filthy water. Underground drainage would not answer, because drain-pipes, as such, must be permeable, to carry off surplus moisture from the soil, and therefore are not fit to receive sewage of any kind whatever, as they would allow its penetration into the soil. Hence, sewers in the strictest sense are the only proper receptacles and carriers of sewage, and without them, water-works in any city would soon become a sanitary evil instead of a blessing.

3. Removal of any kind of filth, largely diluted by the addition of water furnished by an ample water supply from water-works, through self-cleansing sewers, is infinitely the least offensive and least dangerous method of removal. Pollution of the water-courses into which it is discharged, if such occurs to any perceptible degree, can be almost entirely prevented by sewage-irrigation.

4. The addition of the urine and fæces of one individual to every thirty-five gallons of water—the usual amount used per head—involves, sanitarily, quite a small, if any risk, but pecuniarily a great saving, as the water, after having been used in the houses, has to be carried off by sewers anyhow, and is a much cheaper motive power than manual and horse labor.

If the danger of the pollution of the running streams and its consequences, by the fresh, undecomposed, and almost inodorous sewage at the outlet of the sewers is so alarmingly great as Dr. G. contends, why is it any smaller from its effect upon the atmosphere, soil and water, when a large portion of the urine and fæces, and almost all other filth, are allowed to accumulate either on the surface or to enter the soil and the water of the city, as must necessarily be the case under Dr. G.'s plan of removal, which takes away so very little and leaves so much in the city.

If the organic germs of specific diseases, such as typhoid fever, cholera, etc., when contained in sewage, now and then produce the disease at a distance, what will they do when they are allowed to find their way into the soil and ground water of a populous city, where soiled filth is allowed to decay promiscuously on the surface, and where the filthy liquid wastes of the city have been allowed to permeate the soil and charge it and the water with putrid organic material? Will they not find a much more favorable medium for abundant reproduction in a much more condensed space than they will in a swift-running brook, exposed to air and sunshine, and do much more injury in the city than in the thinly populated rural district surrounding it? Who can entertain any doubt on this point?

By such sewers and water-closet connections as I recommend the subsoil of the city, the cellars and basements will be relieved from surplus moisture, the accumulation of liquid filth on the surface, its percolation into the soil and wells will be prevented, and all the waste and sink slops from house and kitchen, workshop and factory, and with them the human excreta will be put in motion as soon as deposited and carried beyond the limits of the city long before any decomposition sets in.

7. Both together are the only measure by which this immediate and almost complete removal of all filth, except street garbage—which of course must be looked after separately—can be accomplished, and all accumulation and stagnation in street gutters and on the surface generally, percolation into the soil and contamination of the atmosphere and water, can be almost entirely prevented.

If we desire to protect the health of the citizens of Atlanta in *good earnest, we must build them* according to the latest rules of sanitary engineering and under a previously matured general plan and system, based upon a topographical survey of the city. *Whenever we do so, then we can conscientiously say that the health of Atlanta is efficiently protected and cared for, and not until then.*

In the mean time it is a matter of course that the condition of the streets, alleys, privies, backyards, basements, and cellars of the city should be carefully watched, and that measures should be taken to prevent any contamination of the atmosphere of the houses, the soil and water of the city from any improper accumulation of filth in these localities.

It is the opinion of the writer that particularly the privies and street gutters in the very heart of the city require the most urgent attention of the City Council, and that the principles laid down in relation to the location and construction of privies, in part 8, of the summary of his first report, deserve careful consideration and early execution.

CH. RAUCHENBERG, M.D.,
Chairman Committee on Sewers and Drains.

On motion, the President was authorized to appoint a committee to take under advisement the papers and discussions before the Commission and report to the Board the best plan for the removal of excreta for Atlanta, and for the sanitary regulation of the city—which plan, if adopted by the Board, to be submitted to the City Council.

The President appointed as this committee, Messrs. DeGive, Stephens and Taliaferro.

At a meeting of the Commission, held November 30th, 1876, the committee appointed for the purpose, reported through their chairman, Mr. DeGive, the plan agreed upon, for the removal of refuse, best adapted to the city of Atlanta. This report, being submitted, by sections, to a vote of the Commission, was agreed to, except by Dr. Rauschenberg, and, on motion, ordered to be presented to the City Council, at their next regular meeting, by the President and Secretary, as the final report of the Commission.

Dr. Rauschenberg gave notice that he should present, at the same time, a minority report, dissenting from the conclusions of the Commission.

On motion the minority report of Dr. Rauschenberg was ordered to be presented to Council with the report of the Commission.

These reports will be found as follows:

REPORT OF THE SANITARY COMMISSION APPOINTED BY THE CITY COUNCIL.

The Commission appointed by the Mayor and Council to investigate the subject of sewerage, and the disposal of excreta, as connected with the city of Atlanta, beg leave, respectfully, to make the following report:

They have to say, as preliminary to the presentation of their conclusions, that this investigation has been made with great care, and at the cost of much labor, especially upon the part of the chairmen of three committees appointed by the Commission, to collect all possible facts bearing upon this this subject in all its aspects.

It is believed that, whether the conclusions of the Commission are correct or not, a mass of information upon this subject has been collected, and will be found accompanying this report, which contains all important facts which could be drawn from the experience of the cities of this continent, and of Europe, thereby enabling the Mayor and Council of this city to have ready access to ample facilities for a wise determination as to the plan to be adopted for securing to Atlanta the best possible sanitary condition.

J. P. LOGAN,
President Sanitary Commission.

V. H. TALIAFERRO, Secretary.

Report of the Special Committee of the Sanitary Commission, adopted, and ordered to be presented to the Mayor and Council by the President and Secretary of the Sanitary Commission, as their final conclusions.

The city of Atlanta is remarkable for the absence of watercourses, or of any large collection of water. It is not located as most cities of the old, or of the new world, upon, or near, a river, on the shores of a lake, or of the sea. It is located upon the crest of a mountainous region, where a few springs have given birth to four or five small streams of a few inches volume. It is enough to look at these branches to have it demonstrated that they cannot be used as carriers of the whole of the foul matter of the city, especially of the excreta, solid and liquid of the inhabitants. Therefore, if a system of sewers should be adopted for the city of Atlanta, for the purpose

of disposing of these excreta, such sewers could not be emptied in the branches. They would transform the latter into open sewers, and into hot-beds of all kinds of disease, breeding germs of death all around the city. The water would be polluted for long distances, and those living in their vicinity would institute suits, obtain damages, and finally stop the nuisance.

This point once admitted, that the excreta cannot be delivered into the branches, they must, if allowed in the sewers, be disposed of at the end of each main.

Two modes are proposed for that: one recommended, consists in collecting the sewer matters in vast reservoirs, or immense tanks at the end of each main, to allow the solid parts to settle in these tanks and then to convert them into fertilizers. As is apparent, this system would necessitate as many reservoirs and manufacturing establishments as we would have of main sewers, say four or five. At each copious rain the reservoirs would overflow and their contents would be carried into the branches. In investigating carefully the workings of the whole process, we soon reach the conclusion that it is impracticable and must be rejected.

The second mode advocated, consists in using the discharges of the sewers at the end of each main for irrigation. The question of using sewer matters for irrigating purposes is still a matter of experiment; but we know enough to say, that as far as determined, the experience of others does not warrant the adoption of it by our city. Nearly all the cities that have adopted it have surrendered it, and some of the highest sanitary authorities condemn it. Some experiments are still in progress; but the probability is that they will not prove more successful than those already abandoned. Atlanta cannot embark in these costly and dangerous experiments.

Supposing that the experience of others would not be considered as a conclusive argument, we have in our own case some sufficient reasons to reject it. The discharges of our sewers would be composed of human excreta and house slops. We know how limited is our supply of water; we know how little of it we can spare for our water-closets, and that this little is to be divided between four or five main sewers. Therefore it is certain that the discharges of our main sewers will

be foul, thick, and sluggish. The ditches through which they will have to be distributed in the fields will be as many open sewers, soon filled at the bottom with a slimy and foul paste of organic matter; the whole irrigated field will be covered with a thick coating of the same. The stench emanating from these ditches and fields will be unbearable, and putrid fermentation during the hot season would constantly develope the most deadly poisons. Atlanta then would be encircled by four or five great laboratories of stench and pestilence, so that from whatever point of the compass the wind would come, it would bring both, to the nostrils and lungs of our citizens. The ground upon which experiments have been made in Europe, differs also: there, irrigation has been tried on low and flat lands. If we survey the lands on our branches near the city, we see that they are hilly, cut up by gorges, and that they are not adapted to irrigation. It would be impossible to find farmers who would assume the obligation of using the whole year round, the discharges of our main sewers, and it is out of the question for Atlanta to buy the lands and establish irrigating farms. For these reasons nothing is left but the conclusion, that the second mode of disposing of the contents of our sewers by irrigation cannot be adopted, at least, in the present state of the question.

The rejection of these two modes of disposing of the sewer discharges, forces upon us the other conclusion, that human excreta, solid and liquid, and all other solid filth, must be excluded from the sewers, and removed by wheel carriage. Many cities, like Paris and numerous English towns, possessing sewers and large water-courses, and even swift rivers, able to receive and carry away the contents of the sewers, have retained, or, after careful examination, have adopted this mode of removal as the most desirable.

Atlanta is so geographically situated that there is no choice, and must, of necessity, submit to the same method. Other systems may be more neat, may present more conveniences or facilities to indolent laborers and to careless or fastidious masters; but as they are not in our reach, our people will do well to abandon all idea of what is clearly impracticable.

The removal by wheel labor, or as we shall hereafter call it, the removal process, has proved by the experience of other

cities to be very efficient in a sanitary point of view. The Governor of Paris and Department of Seine, in his answer of March 22, 1876, to the questions addressed to him by the Commission, declares that the removal process has nothing whatever injurious to the public salubrity, and that neither the medical faculty nor the sanitary authorities have found to this day that the system was attended with any bad results upon the public health.

The removal process has also been found to work well in the cities that have by choice or by necessity used it. Of course, suitable regulations have to be made and enforced, but they are of such a nature that once well understood, and their necessity demonstrated, the working of the system will present no difficulty. The removal process can claim above all others some points of excellence. It is the one that gives the best results for the manufacture of fertilizers, in saving more of the useful chemicals contained in the liquid excreta. Over the rrigation system it excels in this point, that it allows the creation of a good fertilizer, that can be transported and used where it will do the most good, instead of nearly all being wasted by over-saturating a few acres. Its product, raw or manipulated, will be immediately sought by our gardeners and farmers, and the demand will always exceed the supply. Experience shows that where the removal system has been established, companies have been immediately formed to purchase the exclusive right of removal, and convert the matters into fertilizers. The cities have in most cases derived a revenue from that source, or at least have been relieved of the trouble and expense of making the removal.

In the present financial condition of Atlanta, the removal process has also this great advantage, that it settles the question of salubrity without forcing us to embark in the construction of a complete system of sewers, whose cost cannot be properly estimated, and may absorb hundreds of thousands of dollars that we could not spare. The adoption of it may bring a little expense upon each one of a few of our property owners in the center, but they can better afford it than the city.

In applying the removal process we must remark, again, that our city presents a peculiar feature that we do not find in any European city, and this peculiar feature involves the

task of removal. All European cities are compact, houses joined to houses. Here, our center, alone, has the same character, and the balance resembles more a thickly settled European district, each house having flower and vegetable gardens more or less extensive. The central part, and what must be grouped with it, as the schools, etc., is, in extent, very small. Its population, permanent, or brought there every day, by business in stores, hotels, schools, etc., can safely be asserted not to exceed one-fourth of our whole population; therefore, we will not have more than ten thousand souls whose excreta will have to be removed by cart, out of the city limits. The experience of Paris shows that one cart, carrying twelve tubs, makes two trips a day, to a point five miles out of town, and serves, in that way, four thousand souls. Our distances being shorter, we can safely rely upon the same maximum of expense, and we can say, therefore, that 2½ carts will remove the whole excreta of the central part of Atlanta, including schools, etc. If the city would assume the trouble and expense of the removal, it would be a small matter. But, as the city is under no obligation to clean the privies of her citizens, they ought to pay a fixed fee for each operation. As soon as companies take hold of the removal, the city will, at least, get rid of the trouble and expense, if she cannot, besides, realize a profit. In the largest portion of the town, amounting to nine-tenths of its area, and, in population to about three-fourths, no removal is necessary, although it can be allowed to the persons who prefer it, and required of them unless otherwise used. There the privy contents, the kitchen slops, the soap-suds, etc., ought to be disposed of in the gardens as fertilizers. They are all valuable manures, and used as such, properly mixed with the soil, they are perfectly innocuous.

This broad world is covered with a thick layer of vegetable and animal matter; these have been accumulating and being absorbed by plants since the day God created animals and vegetation, and still the human race, from one pair, has grown to be over thirteen hundred millions of souls, and these have found always an abundance of pure water to satisfy their needs.

The earth, with which the matters are so mixed in our gardens, deodorizes them, and in that state of mixture, putrid fermentation cannot take place.

It must never be lost sight of that malaria, and all the germs of zymotic diseases, call these germs animalculæ or cryptogams, are engendered or propagated by putrid fermentation of vegetable or animal matters, and that these matters cannot engender or propagate them without said putrid fermentation. Therefore, what must be avoided around houses, is every accumulation of these matters in holes or heaps, in a sufficient state of moisture and heat combined, so as to produce fermentation. A sanitary ordinance must regulate all details concerning the privies, their distance from wells, or dwellings, their construction, the time and mode of cleaning, etc.

It will have, also, to prescribe what chemicals will have to be used in privies to prevent fermentation in the intervals of cleaning.

A very important question is the determination of the kind of receivers to be adopted in the central part of the city. These receivers will have to be tubs or cemented vaults, at the choice of the property owners, or as the ordinance may determine. As much as possible, tubs ought to be preferred. For large houses, schools, hotels, etc., vaults may *possibly* be used. By the experience of others we are taught what kind of tubs or what kind of vaults we can use with safety, and the sanitary ordinance will regulate all details, and also provide remedies for the effects of negligence, or for the conservation and repairs of vaults, etc., etc.

Besides human excreta, we find in every city a large amount of other filth that has to be disposed of. This filth is solid or liquid. The solid is composed of the excreta of animals, the kitchen refuse, the solid particles in kitchen slops, the street sweepings, dead animals, etc, etc.

Where they cannot be made useful in the gardens, they ought to be removed frequently.

For that purpose the city must establish a most efficient corps of scavenger carts, until somebody takes hold of that removal in connection with the removal of our privies. Another suggestion presents itself: a more regular cleaning and sweeping of our central streets is desirable, and this could be done cheaply by female and feeble male portion of our chain-gang. The liquid filth comprises the scouring, washing, kitchen, and manufacturing waters, urine excluded. These liquids

must also be utilized in gardens in the largest part of the city, and in the center, must as much as possible be directed toward the sewers or *drains*, as existing in the present or in the future. It is important to remark that the center of our city has very little of these liquid matters. The hotels and boarding houses have nearly the monopoly of production of liquid filth there, and most of them are already connected with our sewers. Of course, the sewers or drains, will have in future to be gradually perfected and extended.

Another remark bearing upon our condition, is that Atlanta, on account, both of her rolling soil, which allows a quick and perfect drainage of her surface water, and the small amount of rainy weather in the year, has not so large an amount of filthy water in the street gutters as we see in the cities of England, Holland, Belgium, Germany, etc., etc. In consequence, we have no need of sewers to receive and carry away the filthy waters that do not exist. Our rains as a rule, are heavy, and a few hours after they have ceased, all the water that falls has disappeared, cleansing our city, and leaving the gutters, dry when they are properly constructed.

Finally, we add the accompanying conclusions:

1. Upon the hypothesis that the city of Atlanta should adopt a system of sewers in which the human excreta would be received, the opinion of the Sanitary Commission is, that the contents of these sewers cannot be allowed to discharge into the streams having their source in the city.

2d. Upon the same hypothesis, a method proposed to receive the contents of the sewers at the end of each main in large reservoirs, to be manufactured there into fertilizers, is considered by the Sanitary Commission as impracticable.

3d. Upon the same hypothesis, a method proposed to dispose of the contents of said sewers by the irrigation of land at the end of each main, is considered by the Sanitary Commission as injudicious, from the inherent difficulties in its accomplishment, and as fraught with danger to the health of the city and its vicinity.

4th. The rejection of these methods of disposing of the contents of sewers in which human excreta would be admitted, leaves us the only alternative—the exclusion of said excreta from the sewers or drains, and the necessity of the adoption

of other means of removal. The Commission recommend for this end the use of carts or wagons as the vehicle for the removal, in boxes or barrels, of all human excreta, both solid and liquid, and of all solid foul matters or refuse from the central points of the city, where said foul and refuse matters cannot be, or are not, used for fertilizers in gardens connected with such houses.

5th. The Sanitary Commission offer their aid, if it should be desired by the Mayor and Council, in perfecting the details of the plan recommended, upon the basis of certain conclusions derived from their knowledge of the experience of other cities.

6th. It is recommended that the reports of the committees to the Sanitary Commission, accompanying this report, should be published for the information of the citizens of Atlanta.

7th. That this report should be made to the Mayor and Council by the President and Secretary of the Sanitary Commission.

Respectfully submitted.

L. DeGive,
John Stephens,
V. H. Taliaferro,
Committee.

Atlanta, December 4, 1876.

To the Honorable, the Mayor and City Council of Atlanta:

Gentlemen:—As a member of the Sanitary Commission, dissenting from the conclusions arrived at by the other members, and expressed in their report, presented to your honorable body to-night, I respectfully beg leave to submit simultaneously, a minority report.

I respectfully recommend to your honorable body:

1. For that portion of the city over which the supply of water from the water-works extends, the adoption and gradual execution of a well matured system of sewerage, according to the principles laid down in Latham's work, on sanitary engineering, based upon a correct topographical survey of the city.

2. The gradual introduction of a perfect system of water-closets and sewerage by sewer connection of each house, which is supplied with water from the water-works.

3. The immediate regulation of the location and construction of all privies by appropriate ordinance and surveillance until the time of their abolition by introduction of sewers and water-closets arrives, in such a manner, that percolation of their contents becomes impossible and removal of the same in due time a necessity.

Allow me to assure you that I do most positively know that these are *the only measures* by the adoption of which the health and life of the citizens of Atlanta can be more efficiently, lastingly and economically protected, and any claim, that this is done before their introduction by any other method, is a delusion, and finally, that the objections against these measures contained in the report of the other members of the Sanitary Commission are futile and untenable.

In conclusion, permit me to refer your honorable body to my reports to the Sanitary Commission, made as Chairman of the Committee on Sewers and Drains, for my reasons for the above statements, and at the same time to inform you that I will be happy at any and all times, to sustain my position as well as to give the necessary details for the execution of my measures by future reports, if desired.

I have the honor to be,

Your obedient servant,

CH. RAUSCHENBERG, M.D.

All of which is respectfully submitted to the honorable Mayor and City Council.

J. P. LOGAN, M.D.,
President.

V. H. TALIAFERRO, M.D.,
Secretary.

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ERRATA.

On page 42 (foot-note), in 13th line from bottom, "typhoid" should be in parenthesis.

On page 48, 12th line read "favorable" for "agreeable;" and insert "that" between the latter word and "the water-closet."

On page 71 (foot-note), in 19th line from the bottom, the word "says" should read "say."

On page 86, the 13th line should read: *f.* The sewage must *not* be used on a large scale"—the word "*not*" having been omitted.

On page 91, odorless "evacuating" machines should read "excavating." On same page, and those following, the same correction should be made.

On page 104 (foot-note), 2d line from the bottom, read "fifteen months, *ending* last year—the word "ending" having been omitted.

On page 106, the extract on top of page should be credited to Dr. Verdi.

On page 119, 2d line from bottom of 6th conclusion, the word "fail" should read "fails."